DETERMINANTS OF PHYSICAL ACTIVITY LEVELS: A MULTILEVEL ANALYSIS OF THE AMERICAN COLLEGE HEALTH ASSOCIATION SURVEY

A Dissertation

by

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ABSTRACT

Physical inactivity is one of the primary modifiable risk behaviors for illness and disease. Thus, promoting regular physical activity (PA) is a top priority for most public health organizations. Despite the increasing national effort to promote an active life style, the prevalence of PA is still declining across all age groups. One important segment of the population is college-aged students. Due to the rapid decline in PA after adolescence, the increasing number of young adults who attended college, and the crucial roles such population play in the society, there are increasing calls for more research to understand the determinants of PA among college-aged students.

The purpose of this study is three-fold: to examine the current evidence among theory-based PA studies, to investigate the role of student-level factors in influencing PA, and to study the effects of college-level variables on PA among college-aged students. Examining the current evidence provide a systematic methods to synthesis emergent information, help identify the current directions of PA research, and assess the gaps in knowledge within PA research. Studying the impact of student- and college-level factors assesses the magnitude of each factor in each level, compares factor impact between level, and identifies potential interactions between influencing variables.

The study findings showed that most previous research applied intrapersonal theories to understand and promote PA behavior among college-aged students. However, a growing trend toward a higher-level factors was observed. Such trend is prompted by a widespread appreciation of the complexity of PA and the dynamic interaction across PA levels of influence. Additionally, the findings demonstrated a wide variation between PA studies' designs, methods, and models. Based on the findings of the student-level and college-level variables, both level exerted a

significant impact on PA. However, the greatest impact was from college-level variables. Additionally, the study results showed a significant interaction effects between PA determinants and several students' characteristics.

This study demonstrates that focusing on a single level of influence (i.e., intrapersonal level variables) is insufficient and, even, detrimental because it could lead to erroneous conclusions and misplaced efforts and resources. PA is multifaceted and complex. Thus, a multilevel approach to understand PA among college-aged students is required to effectively promote the behavior. Moreover, observational studies that disregard the impact of bias and risks of validity is ubiquities in PA research. Such study design should be balanced with a more rigorous design such as quasi-experimental methods offer a more reliable and valid findings.

This study's results could inform future research, policies and interventions aimed to promote PA among college-aged students. College health researchers, educators, and administrators can identify current PA patterns and emergent PA determinants to better understand the complexity of the behavior and design well-specified models and tailored programs.

DEDICATION

I dedicate this dissertation to who helped me in my struggle in overcoming all barriers, to who motivated me to complete my academic journey to the highest degree possible, and to who believed in me and knew that I can do it. This is for you.

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This work was supervised by a dissertation committee consisting of Professor Idethia Harvey, Susan Ward, and Kelly Wilson of the Department of Health and Kinesiology, and Professor Wen Luo of the Department of Educational Psychology.

All work for the dissertation was completed independently by the student.

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CHAPTER I

INTRODUCTION AND RATIONALE

Physical inactivity is one of the primary modifiable risk behaviors for illness and disease (Reis et al., 2016). Accumulating evidence suggests that engaging in physical activity (PA) regularly is one of the primary factors in preventing chronic diseases and maintaining people's health and wellness (Keating et al., 2005). Studies have documented the impact of sufficient PA level in preventing certain chronic diseases (e.g., diabetes, coronary heart disease, stroke, osteoporosis, high blood pressure, cardiovascular disease; Blair et al., 1996), protecting against some types of cancer (e.g., breast, colon; Lee, 2003), controlling obesity (Wareham et al., 2005), enhancing overall well-being (e.g., improved quality of sleep, diminished risk of depression and mood disturbances; Paluska & Schwenk, 2000), and improving cognitive capability (e.g., enhance memory, increase cognitive energy; Ruscheweyh et al., 2011).

However, the latest national and global surveillance studies indicate an alarming decline in the prevalence of PA across all age groups (HHS, 2010; WHO, 2016). Thus, promoting regular Physical Activity (PA) is a top priority in most public health organizations and one of the primary goals of Healthy People 2020 (HHS, 2010). Healthy Campus 2020, an adjacent document to Healthy People 2020 (U.S. Department of Health and Human Services, 2000), has emphasized the importance of educating college students and creating a campus environment conducive to health and wellbeing (ACHA, 2010). The rationale for developing Healthy Campus 2020 was in part due to the escalating rate of sedentary lifestyle among college-aged students. In 2010, 48% of college students failed to meet the minimum requirement of aerobic PA, and only 37% participated in muscle-strengthening activities (ACHA, 2010). The Healthy Campus 2020 objective was to reach 53% by 2020 (i.e., 10% increase).

Despite extensive interventions to promote regular PA and improve college students' awareness of PA health benefits, the rate of college-aged students who met the PA recommendations continue to decline (HHS, 2010). The steady decline of PA among college students continues even after graduation, which raises concerns about their current and future health and well-being (Byberg et al., 2009). The growing proportion of students who fail to meet the PA requirements is a significant public health issue because of the fast-growing pace of this population. More importantly, health behaviors and lifestyle habits adopted in college often linger until later into adulthood affecting their wellbeing and their life (Paffenbarger et al., 1986).

Despite a large body of research on the benefits of PA on health and quality of life (Nocon et al., 2008), only a few studies focused on the impact of behavioral, social, and environmental factors on PA among college-aged students and there is limited knowledge about the impact of higher-level (i.e., college-level) factors, particularly among college-aged students. (Biddle et al., 2014).

This study is innovative in two areas: First, the study evaluates the literature based on the adoption of the theoretical framework in designing PA promoting programs. Previous systematic and meta-analysis reviews examined studies concerned with PA prevalence and associations with less regard to underlying theoretical underpinnings. A recent comprehensive systematic review found that most studies employ only student education about PA as the primary tool of intervention (Plotnikoff et al., 2015). Non-theoretical interventions and programs are more likely to be ineffective and inconsistent compared to theory-driven intervention (Glanz et al., 2008). Examining theory-driven interventions provides a reliable and standardized method to identify and compare the effectiveness of different constructs and health models.

Second, the study attempts to examine not only proximal factors, those related to college students such as demographics, socioeconomic status, and academic achievement, but more importantly the higher contributing factors, college-level variables, by utilizing advanced statistical modeling to examine the influence of such factors on PA. The inclusion of higher levels factors offers a holistic approach to explain variation in engaging in PA and between levels interaction.

Purpose

The findings of this dissertation are expected to fill a knowledge gap of multilevel determinants of PA among college-aged students. To establish such purpose, three studies were conducted. The first study systematically reviews the predominant theoretical frameworks that have been utilized to explain and promote PA among college students over the last ten years. The review provides an evidence-based method to reach reliable findings, which can be used to develop interventions, inform policies, and support practices (Shadish et al., 1991) Additionally, results can also add to the emerging literature and expand existing knowledge (Petticrew & Roberts, 2008).

The second study examines the primary determinants of PA level among college-aged students utilizing secondary data from the American College Health Association-National College Health Assessment (ACHA-NCHA) that reflected the characteristics of the target population (i.e., nationally-represented sample of college-aged students). The study used a retrospective cross-sectional design to examine the NCHA secondary data, administered and collected in the fall 2016 semester by ACHA. The finding of such a study can offer college health professionals and administrators the appropriate evidence and knowledge of students'

current health habits, behaviors, and perceived attitudes. Moreover, the results can be used to tailor programs by college health educators and professionals.

The third study assesses the role of higher-level determinants of PA among college-aged students using the NCHA survey. The data include both student-level and college-level variables as the study's research questions aimed to investigate the impact on PA among students and their institutions. Data analysis and model estimations are conducted using the Hierarchical Linear Modeling (HLM) to accommodate the data clustering or grouping within its subjects and the likelihood of correlated errors (Garson, 2014).

Statement of the Problem

Despite the vast body of research on the benefits of PA on health and quality of life (Nocon et al., 2008), few studies targe college-aged students to examine the impact of behavioral, social and environmental factors on engagement in physical activities (Biddle et al., 2014). Therefore, to improve the health of college students and to meet the Healthy Campus 2020 objectives of PA, there is an urgent need to examine the current trends, assess the level of provided health information about PA, and determine potential factors in explaining levels of PA among college-aged students.

Research Questions

The overarching research question was: "Among college-aged students, are multilevel models and theories effective in influencing participation in PA to reach the recommended PA requirements?" The current study addressed this via three individual, yet related, studies which included a comprehensive review of the theory-driven studies in the PA literature, an investigation of the student-level determinants of PA, and an examination of the college-level and student-level determinants of PA. Each study was conducted to stand alone.

This dissertation contains five chapters. In Chapter I (current chapter), an overview of the entire study and brief introduction and rationale is offered. Each of Chapters II, III, and IV is in the form of independent manuscripts described below. Study one adopted a systematic approach to answer the following questions: (1) What was the level of physical activity among college students measured? (2) What theories and model were applied in promoting PA among college students in the last ten years?; (3) What was the quality of theory-based articles designed to understand or promote PA among college students?

The purpose of study two was to examine PA student-level determinants among college-aged students using the NCHA II survey. Two research questions guide the study: (1) What are the primary determinants of PA level among college-aged students?; and (2) To what extent do the primary determinants of PA impact PA among college-aged students?

Study three aimed to examine the role of higher-level determinants of PA among college-aged students using the NCHA II survey. Two research questions guide the study: (1) What are the primary college-level determinants of PA among college-aged students?; and (2) To what extent do the primary college-level determinants impact PA among college-aged students?

Chapter V contained the conclusion, limitations, discussion, implications for practice, and future directions.

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CHAPTER II

THE ROLE OF THEORETICAL MODELS IN EXPLAINING PHYSICAL ACTIVITY AMONG COLLEGE STUDENTS: A SYSTEMATIC REVIEW

Introduction

An accumulating of evidence suggests that engaging in physical activity (PA) is one of the primary factors in preventing chronic diseases and maintaining people's health and wellness (Keating et al., 2005). However, the latest national and global surveillance studies indicate an alarming decline in the prevalence of PA across all age groups (HHS, 2010; WHO, 2016). Health organizations and agencies (e.g., United States Department of Health and Human Services) have launched multiple PA-promoting programs and supported PA research to identify its determinants due to the steady decline in PA rates (Bonevski et al., 2014). Despite such targeted efforts, the decline in PA persists. The prevalence of PA is observed to decline rapidly after adolescence (Bray & Born, 2004). Recently, 48% of college students failed to meet the minimum requirement of aerobic PA, and 37% participated in muscle-strengthening activities (ACHA, 2010). The decline of PA among college students continues even after graduation and into adulthood (Byberg et al., 2009). Physical activity researchers have attempted to understand its determinants and identify the most effective approaches to promote PA among college students.

Description of the Condition

Physical activity is defined as "any bodily movement produced by the contraction of skeletal muscles that results in an increase in caloric requirements over resting energy expenditure" (Caspersen et al., 1985, p. 23). Due to its diverse and broad nature, PA is associated with various types of intensities (e.g., light, moderate, and vigorous activities; ACSM, 2018). Levels of PA intensity are verified through several quantifying methods, such as the percentage of oxygen uptake reserve (VO_2R), the heart rate reserve (HRR), oxygen consumption (VO_2),

heart rate (HR), and metabolic equivalents (METs; ACSM, 2018). Light PA requires limited energy in performing simple activities such as walking, standing to perform light housework, and light sports (e.g., playing billiards; Ainsworth et al., 2000). Moderate PA requires more energy and includes activities such as brisk pace walking, moderate housework (e.g., sweeping floors), and recreational sports (e.g., shooting basketball; Ainsworth et al., 2000). Vigorous PA consumes an enormous amount of energy to compensate for relatively intense activities: moderate- to high-pace running, intense housework (e.g., digging), and competitive sports (e.g., basketball game; Ainsworth et al., 2000).

Physical Activity Current Recommendations

With the existent wide range of types and intensities of PA, health professionals and researchers sought to identify the sufficient amount of PA to maintain people's well-being, reduce susceptibility to adverse health outcomes, and lower the rate of premature death (Haskell et al., 2007). Thus, in 1995, the American College of Sports Medicine (ACSM) in conjunction with the Centers for Disease Control and Prevention (CDC), the United States Surgeon General, and the National Institutes of Health published their first report to clarify the relationship between PA and health outcomes the experts provided the recommendations regarding citizens getting adequate dosage of PA. The report recommended that "every US adult should accumulate 30 minutes or more of moderate PA on most, preferably all, days of the week" (Pate et al., 1995, p. 402). This amount of PA is sufficient to diminish the risk of accumulating body weight, developing chronic diseases, and early mortality (Donnelly et al., 2009). The report also suggested at least two days of moderate or higher intensity of muscle-strengthening activity, such as weight lifting or resistant training.

Several epidemiological studies supported a dose-response relationship between PA and health benefits (Lee et al., 2001; Manson et al., 2002; Tanasescu et al., 2002). Therefore, a higher

volume of PA corresponds to positive health outcomes. Physical activity promotion programs continue to be a top priority within public health agencies. Hallal and colleagues (2011) stated that physical inactivity is the fourth contributing factor to premature death in the US. Additionally, the CDC (2011) reported that 51.6% of adults meet the aerobic activity guidelines, 29.3% meet the muscle-strengthening guidelines, and 20.6% meet both the aerobic and muscle-strengthening guidelines.

Physical Activity among College Students

A growing body of evidence has shown an emerging pattern of early-onset chronic diseases among young adults (i.e., aged 18-24 years; Mokdad et al., 2003; Cook et al., 2003). This trend corresponds to a high rate of physical inactivity among college students (Adlaf et al., 2001). For instance, 44.1% of first-year college students meet the PA guidelines compared with their reported high school PA level when they were in high school (66.2%; Bray et al., 2004). PA patterns established during the college years are more likely to be maintained throughout adulthood leading to decrease risk of several adverse health conditions (Fish & Nies, 1996; Sparling & Snow, 2002). Between 2000 and 2017, the number of adults with a bachelor's degree rose from 29% to 36% (National Center for Education Statistics [NCES], 2018). Since the proportion of students enrolling in colleges and universities is increasing, designing effective interventions to promote PA can enhance engagement in PA among a large segment of society.

Description of the Interventions

Several studies and interventions have been implemented to examine and promote PA among college students (Bauman et al., 2012). The researchers focused on PA by targeting several levels of influence such as personal, social, economic, and environmental determinants (Manson et al., 2002). Within these levels of influence, enabling factors and barriers were modified to improve PA engagement. There is some evidence indicating that interventions

developed to promote PA can initially enhance PA among college-aged students (Sallis et al., 2000). However, it remains unclear which type of intervention is the most effective in establishing a long-term change in PA behavior among college-aged students.

Systematic reviews provide synthesized knowledge regarding PA research. Additionally, systematic reviews help identify the strength and shortcomings of past research (Jackson & Waters, 2005). The number of studies that examined PA interventions among college students has been growing (Baker et al., 2015), especially studies that are specifically theory-driven (Bauman et al., 2012). Despite the increase in theory-driven interventions, to the author's knowledge, no systematic review focused on examining the effectiveness of theory-driven interventions among college students.

Purpose

The purpose of the current study was to systematically review the predominant theoretical frameworks that have been utilized to explain and promote PA among college students over the last ten years. The review adopted a systematic approach to answer the following questions: (1) What was the level of PA among college students? (2) What theories and model were applied in promoting PA among college students in the last ten years?; (3) What were the methodological quality and extent of validity of the reviewed studies?

Methods

The current study used a systematic review to address the review's questions. Systematic reviews synthesize relevant data that investigate areas of uncertainty, identify existing gaps in the literature, and determine future research directions (Mulrow, 1994; Petticrew & Roberts, 2008). Systematic reviews can be used to develop interventions, inform policies, and support practices

(Shadish et al., 1991); results can also add to the emerging literature, expand existing knowledge, or even initiate a paradigm shift in the field (Petticrew & Roberts, 2008).

In the context of PA research, data continues to accumulate regarding the methods applied to promote PA. Although early studies were mostly atheoretical, researchers used reliable and tested variables to measure PA (Dishman, 1988). This initial wave of research compiled an immense knowledge about PA determinants. However, because of the inadequate findings of past studies, it was evident that promoting PA requires a thorough understating of PA determinants in a systematic fashion (Courneya, 2004). Consequently, in the early 1990s, several researchers in the PA research field began to apply theory and integrate theoretical constructs in designing studies and programs (Dishman, 1988). Theoretical frameworks can develop a shared foundation for studying and understanding PA (Michie et al., 2014; Rothman, 2004). Theory-driven research demonstrates the structure within variables, enables research replication, and allows testing of proposed hypotheses (Rhodes & Nigg, 2011).

In the current study, a rigorous systematic review has been conducted to examine the efficacy of theory-driven articles in promoting and understanding PA among college students. The review involved (a) search of selected databases to identify relevant articles, (b) development of inclusion and exclusion criteria for article collection, (c) screening identified articles against established criteria, (d) data extraction to retrieve relevant characteristics in selected articles.

Database Search

A multistage procedure was used to identify and collect theory-based studies in scholarly electronic databases. In the first stage, electronic databases in the social sciences (e.g., PsycINFO, and Social Work Abstracts), education (e.g., ERIC, and Education Abstracts), and

health and medicine (e.g., PubMed, and CINAHL) were systematically searched to identify potential theory-based articles published between 2008 and 2018. The search included most of the study components: title, keyword, abstract, and the body of an article. Simple searching methods and Boolean operators were used to narrow the search to only relevant articles (Reed & Baxter, 2009). These methods were guided by keywords and terms such as university students, college students, physical activity, fitness, exercise, sedentary environment, recreation, and inactivity. In the second stage, reference list and work cited in each selected article were examined to identify additional theory-driven articles. Articles that met the inclusion criteria were included in the sample frame. Subsequently, articles were organized using Endnote to manage citations, abstracts, and documents.

Inclusion/Exclusion Criteria

A set of eligibility criteria were formulated to ensure that all reviewed articles are relevant to the review's questions. Articles had to be (a) written in English, (b) designed as a quantitative study (c) published in a peer-reviewed journal between 2008 and 2018, (d) conducted with a population of college students, (e) explicitly grounded in a theoretical framework, and (f) focused on PA as the primary outcome. An article was excluded from the review if it was (a) an evaluative and review publication such as a meta-analysis, or systematic review, and (b) a specific study conducted to target a sub-group of college students (e.g., college students with diabetes). The rationale for the inclusion and exclusion criteria was of substantive interest and to consider study related to the research question. For instance, the author's main interest was to examine the efficacy of theoretical-based studies on college students. This age group shares distinct personal, social, and environmental characteristics relative to the general population (Simons et al., 2012). Additionally, the search focused on articles published during

the last ten years as it corresponds with the initiation of the health campus's (2010) objectives to promote PA among college students (ACHA, 2008).

Screening of Articles

Rigorous multistage methods were used to screen eligible articles that met the predefined inclusion and exclusion criteria. First, abstracts of articles collected in the initial search stage were read first by the author and then by another researcher to determine articles' relevance to the research questions and topic. The reviewers based their decision on questions generated based on the inclusion and exclusion criteria. These questions were designed to help standardize and guide the selection process; each question had three responses: yes, no, or maybe. Articles that successfully met the eligibility criteria based on the agreement of both reviewers were included in the collected pool of relevant articles. A consultation between the author and the reviewer was performed to determine the eligibility decision for articles that fail to receive one of the reviewers' approval. Second, the reviewers read the articles in its entirety after it passed the abstract screening stage. The articles were verified based on its relevance to the inclusion criteria, and to ensure pertinent data were provided in each article. Each article that was deemed inappropriate or irrelevant to the eligibility criteria were eliminated. Finally, the pool of the eligible manuscripts was examined to extract relevant information. The structured examination was guided by a data extraction method to help compare and evaluate selected articles.

Data Extraction

A structured data extraction form (See Table 2.1) was developed using Microsoft Excel to properly manage the data collection process and create a database for obtained information. The form contained several questions aimed to identify and code relevant characteristics in each reviewed article. The goal of the coding schema was to standardize data collection, reduce bias,

and improve validity and reliability (Yin, 2017). The coding method was derived from the review's research questions to extract relevant characteristics such as the study's design, participants characteristics, intervention setting, theoretical model, and outcomes. Additionally, the coding questions were guided by the PICOS protocol (i.e., Participants, Interventions, Outcomes, and Study design). Article's characteristics identified as pertinent to the review's questions were extracted based on several developed items. These items were binary in their responses (i.e., 0 = absence of the characteristic or 1 = presence of the characteristic). Thus, reviewers searched each article to identify relevant data and assigned a coding value based on the articles' characteristics.

Quality Assessment

Two reviewers independently assessed the quality of the selected studies that met the eligibility criteria and passed the screening stage. An assessment instrument guided the evaluation process and enabled a structured method to determine an article's quality to ensure a standardized procedure. Developed by the Effective Public Health Practice Project (EPHPP) in 1998, the Quality Assessment Tool for Quantitative Studies (QATQS) aid the reviewers to thoroughly evaluate collected articles and provide a high-quality systematic review (Thomas et al., 1998). Black et al. (2000) tested the instrument's construct validity and test-retest reliability and reported satisfactory findings ($\kappa = 0.74$).

The QATQA, with 19 items, evaluates articles based on several components: selection bias, study design, confounders, blinding, data collection methods, and, withdrawals and drop-outs. These components were rated as strong, moderate, or weak based on a standardized guide (Thomas et al., 1998). Reviewers evaluated each article and determined the overall rating by assessing the six components. Articles with no weak ratings and at least four strong ratings were

considered strong; articles with less than four strong ratings and one weak rating were considered moderate; those with two or more weak rating were considered weak. The review included all three types of studies: strong, moderate, and weak.

Interrater Reliability

Each included article was agreed upon by the author and another reviewer. The agreement was based on several items developed to assess articles' characteristics, quality, and inclusion criteria. These items had a yes or no response. For example, assessment of an article's quality included the items "*Was the study described as randomized*?" The level of agreement between the reviewers was determined using Cohen's kappa, a statistic used to examine interrater reliability by comparing the percentage of agreed on items to the total of items (McHugh, 2012).

Results

In the initial search of the electronic databases using the specified key terms, 1634 articles were identified. This pool of article went through the first screening stage. After screening all the articles, 1419 were excluded for not meeting the eligibility criteria, and 215 articles proceeded to the second screening stage. In term of the inclusion criteria, all reviewed studies excluded students with mental or physical disabilities and students with extreme obesity (i.e., BMI > 40). Among the 215 identified articles, 20 met the inclusion criteria of the current systematic review after reading the articles in its entirety, examining the references list, and reviewing additional manuscripts cited in the articles (See flowchart in Figure 1). The agreement between the two reviewers was substantial (*Cohen's kappa* = 0.78)

The number of participants in each article ranged from 62 to 2,784 students (M = 556, SD = 32). Regarding the type of the study, only five articles (i.e., 25%) adopted an experimental approach (e.g., randomized control trial) to assess the utility of the theoretical framework with a

time of follow-up ranged from 6 weeks to 6 months (Magoc et al., 2011; Wadsworth & Hallam, 2010; Skar et al., 2011; Ince, 2008; Molloy et al., 2010); the remaining articles adopted cross-sectional research designs to examine the level of PA.

The articles had different target populations and inclusion criteria. Three articles focused their analysis on freshmen students (Kwan et al., 2009; Farrena et al., 2017; Skar et al., 2011); two examined only female students (Milroy et al., 2015; Wadsworth & Hallam, 2010). In addition, one article focused primarily on students in physical education and health-related courses (Xiong et al., 2017;), and one examined only on-campus students (Kwan et al., 2009). In terms of response rate, all articles had a response rate higher than 40%, the average response rate for surveys of undergraduate students (Porter et al., 2004). Concerning the article's population country, nine (i.e., 45%) were conducted in the United States (Blanchard et al., 2008; Magoc et al, 2011; Milroy et al., 2015; Farrena et al., 2017; Nehl et al., 2012; Wadsworth & Hallam, 2010; MacCann et al., 2015; Han et al., 2017; Linder et al., 2017), six (i.e., 30%) were from Europe (Molloy et al., 2010; Koring et al., 2013; Ince, 2008; Skar et al., 2011; Xiong et al., 2017; Ersoz, 2016; García et al., 2010), and one article was from Canada (Kwan et al., 2009;), Australia (Allom et al., 2016), China (Xiong et al., 2017), and Nigeria (Essiet et al., 2017).

*Question 1: How was the level of physical activity among college students measure*d*?*

In the articles, researchers quantified students' level of PA by employing several methods of measurements. The predominant instrument was the self-administered International Physical Activity Questionnaire (IPAQ). This instrument was utilized in seven (i.e., 35%) of the reviewed papers (Magoc et al., 2011; Ince, 2008; Koring et al., 2013; Farrena et al., 2017; Wadsworth & Hallam, 2010; Xiong et al., 2017). Other self-administered instruments were also employed: the Godin Leisure-Time Exercise Questionnaire (Blanchard et al., 2008; Molloy et al., 2010; Nehl et

al., 2012; Linder et al., 2017), Global Physical Activity Questionnaire (García et al., 2010), and Self-Administered Past-week Modifiable Activity Questionnaire (Han et al., 2017; Essiet et al., 2017). In the remaining articles, PA was measured using a single-item construct defined by the article's authors (Kwan et al., 2009; Milroy et al., 2015; Allom et al., 2016; Skar et al., 2011; MacCann et al., 2015; Ersoz, 2016).

In addition to the self-reported (i.e., subjective) methods of measurement, several articles supplemented their PA instrument with an objective tool to accurately measure PA. For instance, in two articles (i.e., 20%), a pedometer, a device that estimates the number of steps a person take, was utilized to measure PA objectively in addition to the self-administered questionnaire (Koring et al., 2013; Han et al., 2017). In the articles, the pedometers were provided for the participants to wear for seven consecutive days. No substantial differences were observed between a student's PA level measured with the self-reported scale compared to the pedometer.

Question 2: What theories and model were applied in promoting PA among college students during the last ten years?

Among the 20 articles, five theories and models were applied to promote or understand PA among college students. Of these articles, seven (i.e., 35%) employed the Social Cognitive Theory (SCT) (Ince, 2008; Magoc et al.,2011; Koring et al.,2013; Farrena et al., 2017; Nehl et al., 2011; Wadsworth & Hallam, 2010; Xu et al., 2017), seven (i.e., 35%) applied the Theory of Planned Behavior (TPB) (Blanchard et al., 2008; Molloy et al., 2010; Kwan et al., 2009; Allom, et al., 2016; Skar et al., 2011; MacCann et al., 2015; Linder et al., 2017), and the remaining articles utilized other theories or models: The Self-Determination Theory (SDT; 10%) (Milroy et al., 2015; Ersoz, 2016), Transtheoretical model (TTM; 10%) (Xiong et al., 2017; Han et al., 2017), and ecological model (i.e., 10%) (Essiet et al., 2017; García et al., 2010). In six (i.e., 30%)

studies, theories and model were combined with other behavior-related constructs (Molloy et al., 2010; Koring et al.,2013; Kwan et al., 2009; Allom, et al., 2016; MacCann et al., 2015; ; Ersoz, 2016). Expanding selected models and theories increased the explanatory power and tested other potential factors. For instance, the SCT was combined with preparatory behavior; the TPB was combined with personality traits, self-efficacy, planning, habitual PA, and past behavior; SDT was combined with social physique anxiety.

In seven articles reviewed, the SCT was applied to promote PA among college students (Ince, 2008; Magoc et al.,2011; Koring et al.,2013; Farrena et al., 2017; Nehl et al., 2011; Wadsworth & Hallam, 2010; Xu et al., 2017). Self-efficacy significantly influenced PA in all (Farren et al., 2017; Ince, 2008; Koring et al., 2013; Magoc et al., 2011; Nehl et al., 2012) but one of the studies (Wadsworth & Hallam, 2010). Two studies examined the moderation effect of gender on the relationship between PA and self-efficacy (Nehl et al., 2012; Xu et al., 2017). One of the two studies observed a significant moderation effect (Xu et al., 2017); male students had a higher correlation between PA and self-efficacy compared to female students (Xu et al., 2017). Self-regulation had an inconsistent impact on PA. A significant association between self-regulation and PA was reported in three studies (Magoc et al., 2011; Nehl et al., 2012; Wadsworth & Hallam, 2010). This relationship between self-regulation and PA was moderated by time. Thus, the extent of the impact of self-regulation on PA diminished substantially after six months (Wadsworth & Hallam, 2010). The outcome expectancies construct was not associated with PA in most of the studies (i.e., 85%) (Ince, 2008; Magoc et al.,2011; Koring et al.,2013; Nehl et al., 2011; Wadsworth & Hallam, 2010; Xu et al., 2017). Only one study reported a significant impact of outcome expectancies on PA (Farrena et al., 2017). This relationship was moderated by gender. As outcome expectancies grew, males' students were more likely to meet

PA guideline than female students (Farren et al., 2017). The social support to engage in PA was incorporated in four of the seven SCT-guided articles (Magoc et al.,2011; Nehl et al., 2011; Farren et al., 2017). Positive social support students received from friends and family were consistently a significant predictor of PA. In terms of the PA variability explained by the SCT, most of the correlational studies failed to report the proportion explained by the proposed models. Nehl et al. (2012) proposed a comprehensive model that included self-efficacy, attitude, self-regulation, social modeling, social support, mood, and perception of the campus's recreational facilities. This model accounted for 20% of the variance in PA (Nehl et al., 2011).

The current systematic review identified seven articles (i.e., 35%) that adopted TPB as the theoretical framework (Allom et al., 2016; Blanchard et al., 2008; Linder et al., 2017; MacCann et al., 2015; Molloy et al., 2010; Skar et al., 2011; Wing Kwan et al., 2009). In the articles, the construct intention to engage in PA was the predominant factor in predicting PA. In all but one of the identified articles, students' intention significantly correlated with PA (Skar et al., 2011). Skar et al. (2011) reported the only limited impact of intention on PA in their randomized control trial. Student's race moderated the intention-PA relationship. Caucasian students had a higher intention-PA relationship than Black students (Blanchard et al., 2008). The Perceived Behavioral Control (PBC) construct proved to be a critical determinant of PA. PBC, together with intention, accounted for nearly one-third of the variance in PA (Allom et al., 2016). In addition to its direct impact on PA, PBC partly mediated the effect of social support on PA (Allom et al., 2016). The attitude construct was examined in all the articles (Allom et al., 2016; Blanchard et al., 2008; Linder et al., 2017; MacCann et al., 2015; Molloy et al., 2010; Skar et al., 2011; Wing Kwan et al., 2009). However, the findings were inconsistent. Attitude has a significant association with PA in some articles and little to no correlation in others. Allom et al.

(2016) cited attitude as a primary predictor of intention; attitude along with PBC explained 63% of the variance in intention. However, the impact of attitude on the level of PA was not significant in other investigations (MacCann et al., 2015; Kwan et al., 2009). Similar to the attitude construct, the impact of subjective norm on PA was inconsistent. In two studies, the subjective norm was insignificant in influencing PA (Allom et al., 2016; Skar et al., 2011). However, in other articles, the subjective norm exerted a significant effect on PA (Kwan et al., 2009; Linder et al., 2017; Molloy et al. 2010). Student's gender moderated the relationship between PA and subjective norm effect. Female students with low subjective norm had lower PA level compared the male students (Molloy et al., 2010).

The current review identified several articles that adopted other theories and models such as the TTM, SDT, and ecological models. The application of TTM showed insignificant influence on PA (Han et al., 2017; Xiong et al., 2017). However, some TTM processes (i.e., consciousness raising, environmental reevaluation, counter conditioning, self-liberation, and stimulus control) were observed among participants in later stages (i.e., preparation, action, and maintenance). More specifically, students in the maintenance stage reported significant scores of self-efficacy to engage in PA compared to other stages (Han et al., 2017). Two articles examined the utility of SDT in promoting PA (Milroy et al., 2015; Ersoz, 2016). Amotivation, introjected regulation, identified, and intrinsic regulation were significantly related to PA (Ersoz, 2016; Milroy et al., 2015). Among the behavior regulation types, intrinsic regulation exerted the most influence on PA (Ersoz, 2016). Lastly, the ecological model was examined in two studies (Essiet et al., 2017; Molina-García et al., 2010). Essiet et al. (2017) considered the role of the psychosocial, social, and physical environment factors. PA was significantly related to self-efficacy, perceived barriers, social modeling, and availability of school facilities for outdoor

recreation. Molina-García et al. (2010) found similar findings: PA was significantly associated with self-efficacy, barriers to active transport, walking and cycling facilities, and distance to the university.

Several researchers expanded their proposed models by adding other health-related variables such as social physique anxiety, past behavior, habitual PA, personality traits, planning, and preparatory behavior (Molloy et al., 2010; Koring et al.,2013; Kwan et al., 2009; Allom, et al., 2016; MacCann et al., 2015; Ersoz, 2016). A student's personality trait had an insignificant association with PA. However, students with a high emotionality trait had a significant but minor negative correlation with PA (MacCann et al., 2015). As in the personality trait variable, a student's past PA behavior was a trivial determinant of PA; past PA behavior accounted for only 1.5% of the variance in PA (Kwan et al., 2009). The extent to which PA was being performed habitually had a significant influence on PA. The habit variable accounted for 8% of the variability in PA (Allom et al., 2016). The student's perceived anxiety over appearance was added to the SDT and had a significant association with PA (Ersoz, 2016). In the same study, the relationship between social physique anxiety and PA was moderated by gender; female students with high social anxiety regarding their bodies had higher PA compared to male students (Ersoz, 2016).

Question 3: What was the quality of theory-based articles designed to understand or promote PA among college students?

Three of the 20 articles were rated as having a strong quality based on the EPHPP quality assessment tool (Magoc et al., 2011; Skar et al., 2011; Wadsworth & Hallam, 2010). These studies fulfilled most of the instrument's six components. However, moderate bias still existed due to limitations form data collection methods (Magoc et al., 2011), confounders (Wadsworth &

Hallam, 2010), and withdrawals and drop-outs (Magoc et al., 2011; Skar et al., 2011). All three studies exhibited a moderate risk of bias due to the lack of participants and assessors blinding, and selection bias (Magoc et al., 2011; Skar et al., 2011; Wadsworth & Hallam, 2010).

Half of the reviewed articles (i.e., ten articles) were rated as moderate in their assessed quality. All ten articles showed a risk of bias due to blinding and study design. Two of the ten articles adopted a quasi-experimental design (Ince, 2008; Koring et al., 2013); the remaining had a survey design (i.e., correlational study) (Milroy et al., 2015; Nehl et al., 2012; Xiong et al., 2017; MacCann et al., 2015; Essiet et al., 2017; Ersoz, 2016; García et al., 2010; Xu et al., 2017). Other risks of bias included selection bias (Ince, 2008; Koring et al., 2013), confounders (Milroy et al., 2015).

Of the 20 reviewed studies, seven were rated as exhibiting a weak quality. These articles demonstrated a high degree of bias on several components of the quality assessment tool. Risk of bias due to study design, blinding, and selection bias was observed on all seven articles. For instance, some articles had risk of bias due to confounders (Linder et al., 2017; Han et al., 2017; Kwan et al., 2009; Farrena et al., 2017), and data collection methods (Blanchard et al., 2008; Molloy et al., 2010; Linder et al., 2017; Allom, et al., 2016).

Discussion

This systematic review examined the utility and effectiveness of theories and models adopted to promote and understand PA. The study reviewed theory-based studies that were conducted in the past ten years and targeted college students. To ensure standardized articles collection and review processes, the author formulated structured screening protocols, predefined review questions, and concrete eligibility criteria. Articles were identified by searching several electronic databases in PA related fields: social sciences, education, health, and medicine. The

pool of articles was screened in a cyclic, multistage method by the author and another reviewer to determine relevant studies. After the screening stage, 20 articles met the review's eligibility criteria. The theories adopted by these articles were limited to SCT, TPB, SDT, TTM, and the ecological model. Among the identified studies, the SCT and TPB were the most applied theories. However, the constructs of these theories varied in their significance and the magnitude of influence. The findings of the remaining theories were inconsistent.

In the reviewed articles, indirect relationships, such as confounding and moderating effect, was reported. The existence of a moderation effect moderator can potentially alter the strength of existing relationships between the outcome variable and its predictors. For instance, in the current review, a student's race was a prominent moderator of the relationship between PA and a student's intention to engage in PA (Blanchard et al., 2008). Thus, compared to White students, Black students had a diminished PA-intention association. In Molloy and colleagues study (2010), they found that students' gender influenced the relationship between PA and perceived social support as well as between PA and outcome expectancies. However, the moderators' investigation was limited to the previously mentioned two studies (Blanchard et al., 2008; Molloy et al., 2010). In the PA literature, researchers discovered several moderators such as a student's income or socioeconomic status, parents' educational attainment, and the school's environment (Bauman et al., 2002). However, such variables were not integrated into theory-based articles. Thus, in order to close this gap of knowledge, more research is needed to examine emerging variables and their role in affecting PA change. Understanding of the roles and types of PA moderators has several research and policy ramifications; while, identifying PA moderators can help guide researchers to design more accurate models and inform policymakers to develop targeted programs to ensure effective interventions.

Among the reviewed studies, researchers selected theories that differ in their level of influence. Some researchers intended to investigate the role of intrapersonal variables (e.g., knowledge, attitudes, beliefs, and personality). Others targeted variables in more broad levels of influence (e.g., social, cultural, organizational, policy, and environmental levels). Such difference led to a wide variation in the explanatory power between the reviewed studies. Multilevel theories significantly impacted PA, compared to intrapersonal (i.e., single level) theories. One explanation for such a variation between the studies' explanatory capacities is the model's ability to identify unmeasured variables. The broader the level of influence, the less risk of unobserved and confounding variables (Humpel et al., 2002). Historically, most PA researchers targeted personal-level factors and adopted theories concerned with the individual (Owen et al., 2000; Sallis et al., 1998). However, accumulating evidence has indicated that studies guided by intrapersonal theories have short-term outcomes that diminish over time and inconsistent findings that differ between studies (Sallis et al., 2000).

In the current review, articles that focus more on personal variables showed inconsistent findings. Such inconsistencies can be attributed to several factors such as participants' characteristics, sample size, and measurement tools. Even though all reviewed studies recruited college students as their target population, students' characteristics varied between samples. Variables such as socioeconomic status, parents' educational attainment, and the university's environment can mediate or moderate observed relationships. Omitting such variables, by excluding their effect form the proposed model, eventually can lead to erroneous conclusions (Sallis et al., 2000). Additionally, a study's sample size can determine the likelihood of obtaining statistically significant findings (Bauman et al., 2002). Thus, when examining the statistical significance of a relationship, a study with a large sample size is more likely to report a

significant finding, regardless of the relationship's magnitude. Among the reviewed articles, the sample sizes varied considerably (from 62 to 1,976 students). This wide range might partly explain the substantial inconsistencies among the articles' findings. Another potential explanation is the prevalence of measurement error. Assessing the level of PA among college students is challenging (Baranowski et al., 1993). All reviewed studies relied on participants' self-reported scores. Such a method of measurement increases the probability of error and bias (Sirard & Pate, 2001). Thus, despite measuring the same variables, studies can produce different results causing inconsistency of findings and inaccurate conclusions.

Among the reviewed articles, nine studies adopted intrapersonal theories: TPB or SDT. In articles that applied TPB, the proposed models significantly raised students' intent to engage in PA. However, these models failed to adequately explain or promote the primary outcome (i.e., PA). For instance, the TPB model applied by Blanchard et al. (2008) explained that 65% of the variance in the intention construct; the same model accounted for 10% of the variance in PA. Therefore, the student's intention to perform PA was insufficient to predict PA; other underlying factors that transcend the personal level exerted further influence on PA. A similar pattern was observed in SDT (Milroy et al., 2015). Studies that applied SDT showed the limited impact of SDT constructs on PA (Ersoz, 2016; Milroy et al., 2015). Thus, despite their popularity in PA-related research, TPB and SDT have significant shortcomings that can potentially lead to inaccurate or limited findings.

The relatively low predictive capacity, observed among intrapersonal theories, indicated a need for a different approach. PA is influenced by a variety of factors spreading through several levels of influence. However, PA researchers have been concentrating on factors close to the individual (Bauman et al., 2002). During the past decades, researchers have begun to understand

the multilevel nature of PA determinants and started to adopt broader models (Spence & Lee, 2003). Similarly, the current systematic review observed a shift toward higher-level models and theories: SCT and ecological models.

The SCT extends the boundaries established by individual-based theories by measuring personal characteristics, social factors, and environmental cues (Bandura, 1989). In this review, seven articles were conducted to examine PA determinants based on SCT. These articles varied in integrating the SCT constructs. Some articles applied only self-efficacy and self-regulation; others expanded their investigation by including outcome expectancies, social support, and social modeling. Among the correlational studies, only one reported the PA variance accounted for by the model; the model applied by Nehl and colleagues (2012) explained 20% of the variability in PA behavior. Among the experimental studies, SCT-based interventions exhibited a significant change in PA. However, the observed improvement in PA was unsustainable as the extent of change diminished over time.

Unlike other SCT constructs, self-efficacy had a consistent significant correlation with PA among college students. Six of the seven SCT-based articles reported that self-efficacy was a significant predictor of PA (Ince, 2008; Magoc et al.,2011; Koring et al.,2013; Farrena et al., 2017; Nehl et al., 2011; Xu et al., 2017). In the literature, several systematic reviews observed similar findings across all age groups (Bauman et al., 2012; Keating et al., 2005; Baker et al., 2005). However, in the current review, the SCT-based studies failed to discriminate between two types of self-efficacy: PA adoption and maintenance. According to Schwarzer & Renner (2000), PA self-efficacy is phase-specific; it fluctuates in magnitude and direction over time. Knowledge of such subcategories can identify specific determinants of PA. Thus, future research, concerned

with self-efficacy's effects, should construct measurement instruments sensitive to the phases of PA self-efficacy.

Among the SCT-based articles, some constructs were inadequately measured. For instance, outcome expectations were measured by a single domain construct (Koring et al., 2013). However, evidence from general populations studies demonstrated that the outcome expectations construct as a multidimensional construct; specific outcome expectations can be instrumental (e.g., weight loss) or effective (e.g., enjoyment) (Gellert et al., 2012). In PA research among college students, outcome expectations have been mostly specified incorrectly delaying an opportunity to enrich the knowledge of PA behavior among this unique population.

The current review confirmed a growing trend among PA researchers towards border multilevel theories and models that combined individual, social, and environmental variables. In the past two decades, the interest in multiple levels of influence (e.g., ecological models) has proliferated (Giles-Corti et al., 2005; Sallis et al., 2015). This comprehensive approach enabled researchers to identify potential factors and to examine interactions between variables within and across the levels of influence. Among the 20 reviewed articles, 11 studies adopted a multilevel approach to study PA patterns among college students. These articles' findings indicated the significance of environmental factors, such as the availability of recreational facilities, perceived safety, enjoyable scenery, and walkable environment. Examining such factors expanded the models' predictive capacity to determine contributing factors by exposing underlying mechanisms (Giles-Corti et al., 2005). However, previous research of PA among college students has been more concerned with the built environment attributes and overlooked other ecological domains (e.g., policy level factors). Also, past research focused more on the direct relationships

between PA and its determinants; more research is needed to identify interactions across higher levels of influence.

The current knowledge of PA and its ecological determinants among college students is insufficient and misdirected. As the current review indicated, most multilevel studies focused on the role of the built environment; less attention was directed to understand the impact of policy, organizational factors, and the dynamic interactions across all levels of influence. On the policy level, despite their decreasing rate, the majority of US universities still require their students to complete physical education courses (Hensley, 2000). It is documented that the frequency and quality of such courses promote PA later in life (Strand et al., 2010). However, the current knowledge about the policy factor interaction with other variables in different levels of influence is scarce. In a workshop summary to investigate PA determinants, Pray (2015) highlighted the importance of understanding the role of policy level and urged researchers to include such factors in future ecological models to design sustainable and far-reaching outcomes.

Another implication of the current review is the need to redefine and specify PA behavior in college. Among the reviewed 20 articles, researchers defined PA in a general sense disregarding other subtypes that fall within PA such as walking for transport, playing sports, engaging in a sedentary lifestyle, walking for recreation, and using a gym. Such shortcomings are detrimental to the findings' validity and accuracy. For instance, Pikora et al. (2003) observed a significant difference between walking for transport and training sport. Potential determinants vary for different types of PA, and the settings in which such activities occur vary as well. Thus, the discrepancy in PA types requires tailored models that consider the variation between PA subtypes. Adopting a behavior-specific approach to measure PA enables more reliable and valid measurement tools and reduces measurement error and bias (Troped et al., 2001).

The quality of the reviewed articles varied substantially due to several deficiencies. Most of the studies adopted a cross-sectional survey design (i.e., correlational study). Since correlational studies invite multiple risks of bias (i.e., lack of external validity), most health organizations and academic journals encourage researchers to develop reliable, evidence-based research (Peters et al., 2013). Of the 20 reviewed articles, three articles used an experimental study design. Experimental studies (e.g., Randomized controlled trials [RCT]) are the gold standard because it provides the most reliable method to assess causality and minimize the risk of bias (i.e., selection bias and confounding). However, in real life settings practical, ethical, social, or logistical considerations hinder random allocation. Also, experimental studies' results are limited to their corresponding sample and not representative of the general population (i.e., lack of external validity; Handley et al., 2018). Among the reviewed articles, two adopted Quasi-Experimental Designs (QEDs). Such a design establishes a proper balance between internal and external validity (Campbell & Stanley, 2015). Thus, QEDs have been increasingly adopted in health research (Handley et al., 2018). Thus, future research in PA must formulate more reliable study designs such as QED to assess and promote PA among college students.

Limitations

The current review examined PA theory-based research including emerging potential determinants, studies shortcomings, gaps of knowledge, and areas of opportunity for future research. Despite the review's valuable results, there are some limitations. First, the review included only published studies and searched a limited number of relevant electronic databases. Systematic reviews that restrict their search to published articles (i.e., Publication bias) are prone to overestimating real relationships and underrepresenting the population of published studies (Rothstein et al., 2005). Second, the bias, inherent in human researcher screening, was

unquantifiable and challenging to detect. Though two researchers independently searched, screened, and extracted the articles, bias could occur due to human error and subjective decisions, which is difficult to eliminate thoroughly (Petticrew & Roberts, 2008). However, the review's predefined protocols established criteria, and between reviewers' consultations aided in minimizing such bias. Third, the search's eligibility criteria were deliberately narrow. The review was restricted to articles based on a theoretical framework and precluded studies guided by selected potential variables. Research based on selected variables of interest can offer additional knowledge, identify new variables, and inform future research (Giles-Corti et al., 2005). Finally, due to the limited number of identified articles, the review examined findings from different types of studies. Experimental studies' findings rely on the mean outcome variable difference between the treatment and control group, while observational studies examine the correlation between examined variables. Drawing a quantitative conclusion, form such a collection of studies is unfeasible (Petticrew & Roberts, 2008). Therefore, future research should require more effort in designing studies with valid and reliable methods (e.g., experimental and quasi-experimental) to minimize the risk of confounding and selection bias.

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Figure 2. 1 Flow Chart of the Screening Stages

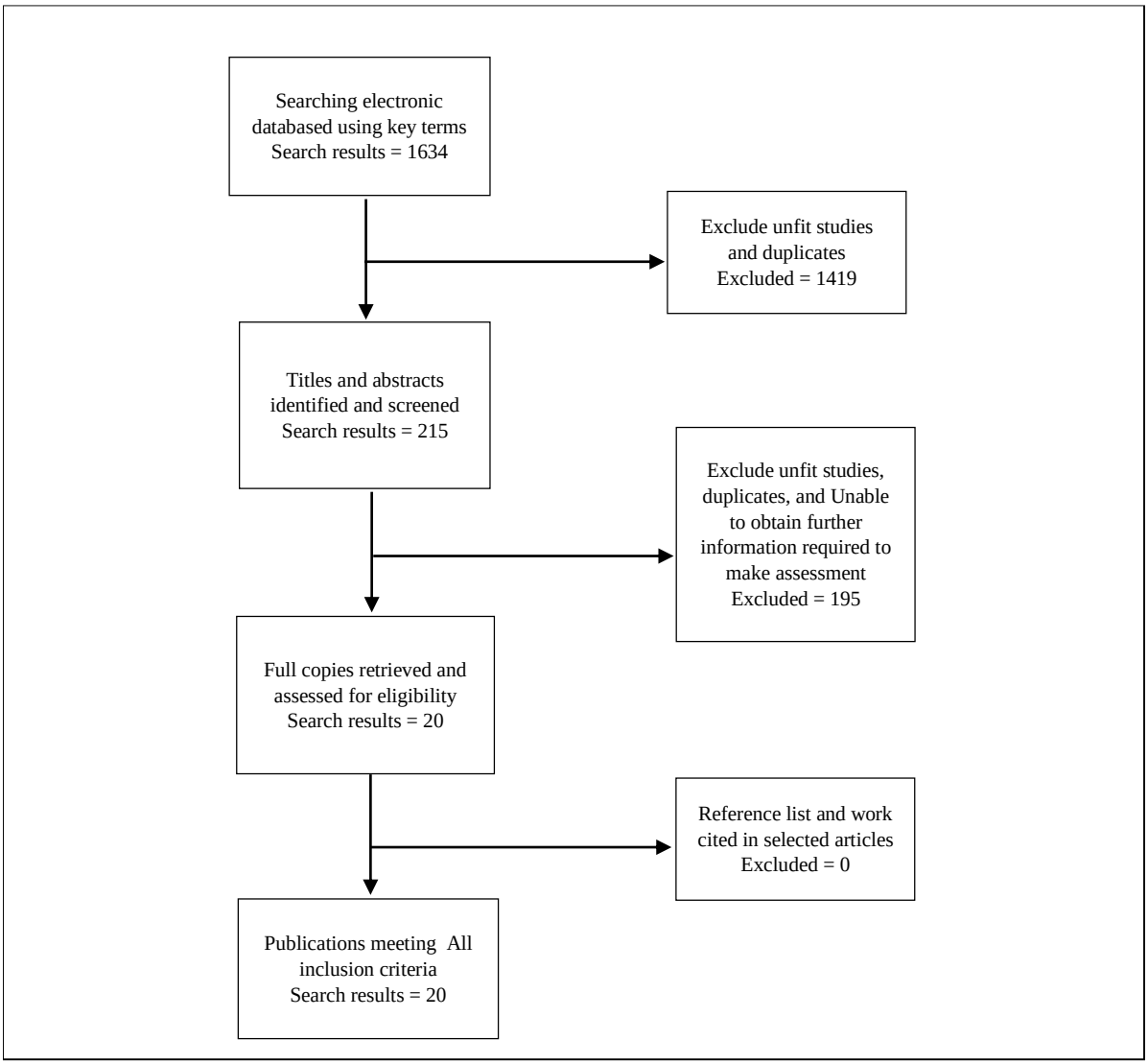


Table 2.1
Systematic Review Data Extraction Form

Study	Country	Target population	study design	Sampling	Inclusion criteria	participants characteristics	intervention setting	theoretical model	Measures	outcomes	length of follow-up	response rate/Attrition	physical activity measures used

Table 2.2

Characteristics of included articles in the systematic review

Study	EPHPP rating	N	Design	Theoretical model	Measures	Outcomes
Magoc et al. (2011)	Strong	117	Experimental study	SCT	Self-efficacy, self-regulation plans, self-regulation goals, outcome expectancies, family social support, and friends' social support	PA was significantly influenced by self-efficacy, self-regulation plans, and social support from friends
Ince (2008)	Moderate	62	Quasi-experimental	SCT	Self-efficacy, social support, self-regulatory skills, and stress management	PA was significantly influenced by self-efficacy, social support, and stress management
Blanchard et al. (2008)	Weak	349	Correlational study	TPB	Intention, attitude (instrumental and affective), subjective norm, and perceived behavioral control	PA was significantly influenced by intention among Caucasian students; the intention–PA relationship was nonsignificant for African American students. The model accounted for 65% of the variance in intention for the Caucasian students (affective and instrumental attitudes and perceived behavioral control were significant); the same model accounted for 49% of the variance in intention for African American students; only affective attitude and PBC were significant.
Molloy et al. (2010)	Weak	903	Correlational study	TPB and planning	Intention, perceived behavioral control, social support, and (action and coping planning)	PA was significantly correlated with All variables. gender moderated the PA-social support relationship; compared to male students, female students with low social support for PA had lower PA. Coping planning may partly explain the social support–physical activity link in women. Perceived behavioral control mediated the effect of social support on regular physical activity in in both male and female students.
Koring et al. (2013)	Moderate	101	Quasi-experimental	SCT and preparatory behavior	Self-Efficacy, outcome expectancies, and pedometer	PA was significantly influenced by self-efficacy; outcome expectancies were not related to PA. Higher self-efficacy in persons who collected the pedometer
Kwan et al. (2009)	Weak	212	Correlational study	TPB and past behavior	Intentions, attitudes, subjective norms, and perceived behavioral control	PA was significantly correlated with past physical activity behavior, intentions, and behavioral control.

Table 2.2 Continued

Study	EPHPP rating	N	Design	Theoretical model	Measures	Outcomes
Milroy et al. (2015)	Moderate	470	Correlational study	SDT	Amotivation, external regulation, introjected regulation, identified regulation, and intrinsic regulation	PA was significantly related negatively to amotivation; positively to introjected regulation, identified and intrinsic regulation; and not significantly related to external regulation
Allom, et al. (2016)	Weak	101	Correlational study	TPB and habitual PA	Attitude, subjective norm, perceived behavioral control, intention, and habitual PA	PA was significantly influenced by intention; intention and perceived behavioral control accounted for 32.5% of the variance in physical activity. The TPB model accounted for 63.1% of the variance in intention; attitude and perceived behavioral control were significant predictors of intention; subjective norm was not
Farrena et al. (2017)	Weak	396	Correlational study	SCT	Self-efficacy, outcome expectancies, and social support	PA was significantly influenced by self-efficacy, outcome expectancies, and social support. Students' gender moderated the relationship between outcome expectancies and PA; as outcome expectancies increases, male students become more likely to meet aerobic PAGs than female students
Nehl et al. (2012)	Moderate	449	Correlational study	SCT	Self-efficacy, attitude, self-regulation, social modeling, social support, mood, and perception of campus's recreational facilities	PA was significantly correlated with all SCT constructs. This model accounted for 20% of the variance in physical activity. The moderation effect of Students' gender between self-efficacy and PA was not significant
Wadsworth & Hallam (2010)	Strong	91	Experimental study	SCT	Self-efficacy, self-regulation, and outcome expectancy value	PA was significantly mediated by self-regulation at 6 weeks, but not at 6 months. Significant differences were not found at 6 weeks or at 6 months between PA and self-efficacy or outcome expectancy value
Skar et al. (2011)	Strong	1273	Experimental study	TPB	Intention, attitude, subjective norm, and perceived behavioral control	No difference in PA was found between intervention and control groups.

Table 2.2 Continued

Study	EPHPP rating	N	Design	Theoretical model	Measures	Outcomes
Xiong et al. (2017)	Moderate	887	Correlational study	TTM	Self-efficacy, decisional balance, and process of change	Self-efficacy was the only significant predictor of PA
MacCann et al. (2015)	Moderate	1017	Correlational study	TPB , self-efficacy, and personality traits	Intention, attitudes, subjective norms, perceived behavioral control, self-efficacy, and personality trait	PBC and intention explained 39.4% of the variation in PA; personality added less than 1% to the model.
Han et al. (2017)	Weak	225	Correlational study	TTM	Stages of motivational readiness, processes of change, self-efficacy, situational confidence, and decisional Balance, and an accelerometer	No significant associations were found between the TTM constructs and PA.
Linder et al. (2017)	Weak	100	Correlational study	TPB	Intention, attitude, subjective norm, descriptive norm, and perceived control behavior	PA was significantly correlated with attitude, intention, and perceived behavior control. The model accounted for 31.7% of the variance in PA.
Essiet et al. (2017)	Moderate	342	Correlational study	Ecological model	Psychosocial variables: self-efficacy, knowledge, attitude, and perceived barriers. Social environment factors: perceived family social support, perceived friends' social support. Physical environment factors: availability of school facilities for indoor recreation, availability of school facilities for outdoor recreation, perceived safety and enjoyable scenery	PA was significantly associated with self-efficacy, perceived barriers, having sibling(s) that are physically active and availability of school facilities for outdoor recreation
Ersoz (2016)	Moderate	612	Correlational study	SDT and social physique anxiety	Exercise regulations, stages of change, dispositional flow, and social physique anxiety	Participants in the preparation stage reported lower introjected regulation scores than those in the maintenance stage; and also participants in the preparation stage reported higher amotivation scores than those in the action and maintenance stage.

Table 2.2 Continued

Study	EPHPP rating	N	Design	Theoretical model	Measures	Outcomes
García et al. (2010)	Moderate	518	Correlational study	Ecological model	Self-efficacy, barriers to active transport, access to car and motorbike, access to public transport, walking and cycling facilities and distance to university	PA was significantly correlated with both psychological and environmental variables. The strongest correlates were access to private transport (car and motorbike), physical self-efficacy, perceived planning/psychosocial barriers and walking and cycling facilities. The model explained a substantial 19% of the variance in PA
Xu et al. (2017)	Moderate	1976	Correlational study	SCT	Self-efficacy, expectations, and self-control	PA was significantly positively correlated with self-efficacy self-control. Compared with females, males had a significantly higher PA self-efficacy and self-control; no significant differences between males and females were observed in expectations.

CHAPTER III

DETERMINANTS OF PHYSICAL ACTIVITY: ANALYSIS OF STUDENT-LEVEL FACTORS OF THE AMERICAN COLLEGE HEALTH ASSOCIATION SURVEY

Introduction

Promoting regular Physical Activity (PA) is a top priority in most public health organizations and one of the primary goals of Healthy People 2020 (HHS, 2010). Such interest is prompted by the pervasive health benefits associated with regular PA. Studies have documented the impact of sufficient PA level in preventing certain chronic diseases (e.g., diabetes, coronary heart disease, stroke, osteoporosis, high blood pressure, cardiovascular disease; Blair et al., 1996), protecting against some types of cancer (e.g., breast, colon; Lee, 2003), controlling obesity (Wareham et al., 2005), enhancing overall well-being (e.g., improved quality of sleep, diminished risk of depression and mood disturbances; Paluska & Schwenk, 2000), and improving cognitive capability (e.g., enhance memory, increase cognitive energy; Ruscheweyh et al., 2011). The overall preventive impact of PA reduces the risk of morbidity and mortality leading to a dose-response relationship between longevity and regular PA (Irwin, 2004).

Due to the wide-range and lasting effects of regular PA, specific guidelines have been developed. In 1995, a workshop, led by 20 researchers and experts in PA behavior, assessed "pertinent scientific evidence" to develop a concise and clear public message about the amount of PA that would provide the optimum health benefits (Pate et al., 1995). One year later, recommendations made by the American College of Sports Medicine (ACSM) in conjunction with the Centers for Disease Control and Prevention (CDC) (Corbin & Pancrazi, 1996) were published to educate the general public regarding the types of PA and the health benefits of moderate and vigorous PA. According to ACSM guidelines, adults, aged 18 to 64 years, should

engage in at least 150 minutes of moderate aerobic PA, or 75 minutes of vigorous aerobic PA every week. In other words, adults should strive to participate in moderate PA for 30 minutes 5 days a week. Moderate PA includes light activities such as walking and biking, while vigorous PA contains more intense activities such as running and swimming. In addition to aerobic PA, ACSM recommended at least two days a week of strengthening training such as weightlifting, pushups, or setups (Corbin & Pancrazi, 1996). The guidelines were highly supported by prominent federal institutions such as the U.S. Department of Health and Human Services (HHS), which based its Healthy People 2010 and 2020 on the ACSM recommendations (HHS, 2010).

Healthy Campus 2020, an adjacent document to Healthy People 2020 (U.S. Department of Health and Human Services, 2000), emphasized the role of educating college-aged students to create a campus environment conducive to health and wellbeing (ACHA, 2010). The rationale for developing Healthy Campus 2020 was based on an alarming rate of sedentary lifestyle and trends of physical inactivity among college-aged students. In 2010, 48% of college-aged students failed to meet the PA minimum requirements, and only 37% participated in strengthening training activities (ACHA, 2010). One of Healthy Campus 2020 objectives was to increase the PA rate to reach 53% by 2020 (i.e., a 10% increase). Universities launched large-scale programs to encourage an active lifestyle to promote PA among undergraduate students, (Lawlor & Hopker, 2001).

Despite the extensive interventions to promote regular PA and improve college students' awareness of PA health benefits, the rate of college-aged students who met the PA federal recommendations continues to decline (HHS, 2010). Keating et al. (2005) conducted a meta-analysis to examine the rate of failing to meet PA guidelines. They estimated that the rate of PA

among college-aged students would continue to rise between 40% to 50% (Keating et al., 2005). Recent studies reported physical inactivity rates as high as 60% (Judge et al., 2012). The growing proportion of students who fail to meet the PA requirements concerns because of the fast-growing pace of this population.

The past few decades witnessed a significant increase in the number of young adults who attended college. According to the National Center for Education Statistics (2018), over the past six years, enrollment in undergraduate postsecondary institutions grew from 13.2 million to 16.9 million students, a 28% increase, and the number is expected to reach 17.5 million students by 2027 (NCES, 2018). The demographics of the population classified as college graduates is steadily growing, and such group represents a vital segment of the general population (Towne et al., 2017). Individuals who have a post-secondary education tend to assume leadership roles in their communities and determine future decisions and outcomes (Huang et al., 200) as well as have the potential to shape social norms and establish cultural standards (Irwin, 2004). More importantly, college-educated graduates are role models for their families, peers, collogues, and the whole community (Wallace et al., 2010). Additionally, health behaviors and lifestyle habits adopted in college often linger until later into adulthood affecting their wellbeing and their life (Paffenbarger et al., 1986).

College-aged students share unique characteristics and experience a critical period of their lives (Clemente et al., 2016). For instance, the transition from being at home to attending college exposes college-aged students to dramatic emotional, financial, and social changes (Gallardo-Escudero et al., 2014). The campus 'community-like' environment have garnered researchers' attention. After enrolling into college, students navigate the principles of autonomy and independence, which prompt them to the work-study balance (Judge et al., 2012).

Additionally, students' unpredictable schedules frequently discourage consistent PA. College-aged students schedule is usually divided between their classes, projects, assignments, social life, and work schedule (Gropper et al., 2012; Judge et al., 2012).

Despite a large body of research on the benefits of PA on health and quality of life (Nocon et al., 2008), only a few studies focused on the impact of behavioral, social, and environmental factors on PA among college-aged students (Biddle et al., 2014). Therefore, to improve the health of college students and to meet the Healthy Campus 2020 objectives of PA, studies should shift their focus towards (1) examining the current trends of PA among college-aged, (2) assessing the awareness level of PA benefits, and (3) determining the probable factors in explaining levels of PA among college-aged students.

Purpose

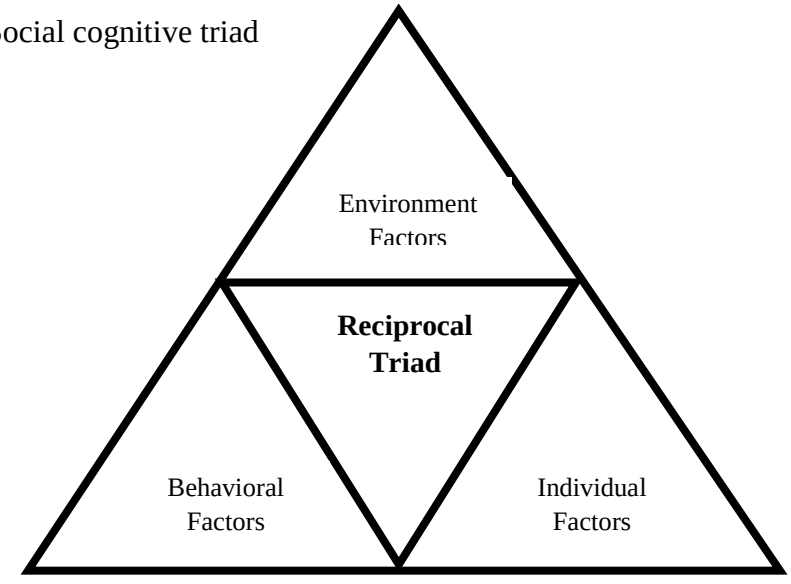
The purpose of the current study was to examine PA determinants among college-aged students using the American College Health Association's (ACHA) National College Health Assessment II (NCHA II) survey. Two research questions that guided the study: (1) What are the primary determinants of PA level among college-aged students?; and (2) To what extent do the primary determinants of PA impact PA among college-aged students?

Theoretical Framework

Most health theories promote preventive behaviors or discourage unhealthy habits by changing predetermined indicators. However, such theories vary in their focus, broadness, and applicability. Some health theories focus on individual influences with little regard to the social and environmental contexts (Miller, 2005). Others health theories extend their scope to include personal, social, and environmental factors. The Social Cognitive Theory (SCT) is one of the latter group. Albert Bandura developed SCT in 1986, an era in which behaviorism thinking was

dominant (Bandura, 2001). Bandura posited that behaviors were partially determined by the person's past experiences, antecedents, and expectancies. In other words, the principle of operant conditioning, in which negative and positive reinforcements promote change, was insufficient to explain individual behavior (Miller, 2005). Bandura believed the interplay between a person's thinking process or a "cognitive dialogue," social determinants, and environmental circumstances determine human behavior (Bandura, 1978). SCT focuses on the dynamic loop of interaction between the individual and their surrounding environment (Bandura, 2001). The notion of interchangeability between external and internal factors is the hallmark of CST; this concept is what distinguishes SCT from individual-oriented theories. Bandura coined the termed "reciprocal determinism" within a "reciprocal triad" (see Figure 1), in which behavior is determined by an interactive cycle between person's behavior and the environment (Glanz et al., 2008).

Figure 3.1 Social cognitive triad



SCT assumed the continuous process of reciprocity and interaction existed between the individual's cognition capabilities, the performed behavior, and the encompassing environment

(Bandura, 1986). This fluid dynamic exchange gives rise to a unique type of agency, the *"emergent interactive agency*" (Bandura, 1986). Bandura asserts that individuals are "neither autonomous agents nor simply mechanical conveyors of animating environmental influences" (1989, p.1175). Thus, human behavior is determined by former experiences, social determinants, and environmental cues.

SCT has been widely applied in numerous studies to evaluate current behavioral patterns, explain persistent unhealthy practices, and predict behavior-modifying strategies. Constructs included in SCT have been empirically verified in several health contexts and settings, such as nutrition, weight control, smoking cessation, contraception usage, and exercise (Bandura, 1992; Catania, Kegeles, & Coates, 1990; Stretcher, DeVellis, Becker, & Rosenstock, 1986). Compared to atheoretical research, studies and interventions employing the principles of SCT are more likely to promote sustainable behavior change (Thirlaway & Upton, 2009). Thus, SCT can offer a multilevel theoretical lens through which the association between PA behavior, the individual, and environmental determinants can be examined and understood.

Social Cognitive Theory and Physical Activity Research

SCT has been applied in PA research with minor adjustments to fit the distinct characteristics of the behavior adequately. For instance, Annesi et al. (2011) introduced the coach approach model, a modified form of SCT in which self-efficacy was exchanged with "mood, perceptions of the body, and relations of improvements in those psychological factors." In another attempt to modify SCT to be applicable in the PA context, Wallace et al. (2000) incorporated constructs from Personal Investment and Stages of Change Model Theory (SCMT) into SCT to help predict participation in PA. Moreover, Leivdai (1993) recognized the importance of SCT in PA, yet she emphasized the need to tailor SCT concepts to suit the context of PA.

Methods

The study examined the primary determinants of PA level among college-aged students utilizing secondary data from the American College Health Association-National College Health Assessment that reflected the characteristics of the target population (i.e., nationally-represented sample of college-aged students). In the current study, the author used a retrospective cross-sectional design to examine the NCHA II secondary data, administered and collected in the fall 2016 semester by ACHA.

National College Health Assessment

The American College Health Association-National College Health Assessment (ACHA-NCHA II) is a comprehensive survey conducted nationwide every year since 2000. The NCHA II has an exhaustive health profile regarding college students' behaviors and attitudes (ACHA, 2013). The ACHA recruited an interdisciplinary team of college health professionals to develop a comprehensive instrument for measuring students' health indicators. The first version of the NCHA consisted of more than 300 items that assessed a multitude of health behaviors, perceptions, and habits of college-aged students (ACHA, 2013). Several of the survey's items represent multiple national health questionnaires such as the Harvard College Alcohol Study (Wechsler & Nelson, 2008), and the Centers for Disease Control and Prevention's College Health Risk Behavior Survey (Douglas et al., 1997). All designed items were psychometrically examined using experts' feedback, pretest assessment, and validity methods (ACHA, 2013). In 2008, the health experts continued the modification procedures and revised the NCHA survey. The process resulted in rewording several measure items, adding items to measure health constructs accurately, and deleting some unnecessary items. The updated version was reevaluated to assess reliability and validity and renamed the NCHA II. NCHA II measured seven critical health domains (1) health, health education, and safety; (2) alcohol, tobacco, and

drugs; (3) sex behavior, perceptions, and contraception; (4) weight, nutrition, and exercise; (5) mental and physical health; (6) impediments to academic performance; and (7) demographics (ACHA, 2013).

The questionnaire offers college health professionals and administrators the appropriate evidence and knowledge of students' current health habits, behaviors, and perceived attitudes. The information generated by NCHA II has been used to tailor programs by college health educators and professionals (ACHA, 2013). For example, Kernan et al. (2011) examined the widespread mental health pattern among college-aged students using NCHA II data while health researchers developed tailored- and evidence-based health promotion interventions (Bulmer et al., 2010; Becker et al., 2008; Blosnich et al., 2010). For college administrators, the findings from the NCHA II created a comprehensive college-related health strategy that helped in the allocation of campus resources.

Data Collection

Higher education institutions were self-selected to participate in NCHA II. The survey was administered to respective students enrolled in the colleges and universities participating in the NCHA II. The procedures involved completing a participation form, submitting a student demographics survey, and mailing a survey order form (ACHA, 2013). Based on selected options, the survey can be web-based, paper-based, or both. If the desired instrument was web-based, a spreadsheet of selected sample's email addresses, letter of consent, participation reminder notification letter, and institutional IRB approval letter had to be submitted. If the institutions selected the paper-based format, the IRB approval letter had to be submitted prior to data collection. Once surveys were completed and collected by the institutions, the surveys were returned to ACHA. ACHA either scanned paper-based surveys or saved electronic data on a

secured website. All data types, web-based and paper-based, were scanned into SPSS to create data codebooks and files, which was sent back to the institution on a CD (ACHA, 2013).

The within-institution sample was selected through a randomized-selection process. The paper-based followed the randomized process by creating a pool of classrooms in the respected semester. After the classroom selection process was completed, students in respective classes represents the sample list (ACHA, 2013). A randomized-selection process through students' emails were performed. Subsequently, the randomized emails were dispatched to ACHA, which ensured the privacy and confidentiality of received information. ACHA emailed potential participants with an invitation link which included a distinct identification number. The period of implementing the web-based survey ranged between two to four weeks in which several reminder notification emails were sent for non-respondents (ACHA, 2013).

Students participation was enhanced when institutions utilized incentives procedures, such as games tickets to athletic events, course credits, or monetary incentives (e.g., cash or gift cards; ACHA, 2013). The incentives procedures increased the response rate, which is beneficial in enhancing the integrity of the data by reducing the amount of missing data (Krosnick et al., 1997). In the current study, the most recently available data were requested by the author. The data represented a survey completed in the fall semester of 2016 and contained approximately 48,000 participants from 92 institutions of higher education. The average response rates were different between the web-based and paper-based surveys. The response rate for the paper-based survey was 81%, while the web-based survey had a 19% response rate. The low response rate in the web-based survey is typical in health assessment surveys in the general population (Musich et al., 2001). Approval for conducting this study was granted by the Texas A&M University Institutional Review Board.

Inclusion Criteria

The NCHA II instrument contained more than 300 items to measure college-related health behaviors. To accurately assess such indicators, specific constructs were developed by ACHA. In the current study, the author selected constructs related to the study's main research questions, and the proposed theoretical underpinnings. The variables selection process was guided by the social cognitive theory (SCT) framework. Inclusion criteria were established by the author to ensure agreement between the analyzed data and the research questions. Among all NCHA II participants who completed the survey, only those between the age 18 and 24 years were selected for analysis since the author research interest was on the impact of PA determinants among this particular age group (Simons et al., 2012). Base on the inclusion criteria, the study sample size yielded to 23,183 participants.

Dependent variable

The outcome variable was based on the PA recommended guidelines. The recommendations were established by federal and national health organizations to encourage adults to meet two categories of PA. The first category of PA is aerobic fitness. The guidelines required 150 minutes per week of moderate aerobic PA or 75 minutes per week of vigorous aerobic PA. Activities such as walking, or biking were considered moderate PA and intense activities such as jogging and swimming were viewed as vigorous PA. The category of PA was strengthening training. Individuals who participated in as pushup, sit-ups, or weight-lifting engaged in strengthen training activities. Three domains operationally defined the PA construct. To ensure each domain was measured appropriately, three items were designed to assess students PA. The NCHA II asked participants “On how many of the past 7 days did you”:

a. Do moderate-intensity cardio or aerobic exercise for at least 30 minutes?

b. Do vigorous intensity cardio or aerobic exercise for at least 20 minutes?

c. Do 8-10 strength training exercises for 8-12 repetitions each?

Respondents were instructed to select a frequency response ranges from 0 – 7 days. The items were designed to cover three dimensions of the PA construct; these domains were specified in the definition of PA behavior. The study's dependent variable was dichotomized to measure participants who met the PA guidelines and those who did not.

Independent variables

The prediction of college students PA level was examined based on association with the independent variables listed in Table (3.1).

Measures

The complexity of PA behavior stems in part from the heterogeneity of its indicators, which can be observed in every level of influence (Dishman, 1988). Primary PA indicators were found in several domains including demographic factors, cognitive variables, skills capabilities, social determinants, environmental cues, and characteristics of the behavior itself (Sallis et al., 1992). Thus, behavior theories and models that adopt a multilevel approach offers a broader and more accurate lens to explain behavior change. The current study's variables were selected form the NCHA II survey based on SCT to examine PA determinants. The hypothesized model was developed to include cognitive, social, and environmental variables that were considered by the author and previous studies to be related to SCT constructs.

Behavior Capability

The construct of behavioral capability emphasizes the role of knowledge and skills in determining human behavior. In the context of PA, engagement in an active lifestyle among students is likely to increase when knowledge of PA benefits, methods, and guidelines is improved (Redding et al., 2000). In the current study, the behavioral capability construct was assessed by measuring the level of PA information a student received from his or her institution.

Students' were asked a yes-or-no question to determine if such information was received. In addition, students were asked a yes-or-no question about their interest in receiving such information form their respective institution.

Perceived Barriers

Perceived barriers refer to obstacles for taking a predetermined action. Based on the performed behavior, deterrents can also be negative consequences. Perceived obstacles vary in their extent from inconvenience to unbearable pain (Sallis et al., 1992). Additionally, barriers can be tangible such as financial cost or psychological such as embarrassment (Hayden, 2013). In this study, the barriers examined focused on individual's obstacles for participating in PA among college-aged students. Three constructs were identified as potential barriers for PA: sleep quality, level of stress, and hours working or volunteering. Sleep quality was measure by asking the participant "Past 7 days, getting enough sleep to feel rested?" Responses were 0 days, 1-2 days, 3-5 days, and 6 or more days. Level of stress was measured by asking the participant "Within the last 12 months, how would you rate the overall level of stress experienced?" Responses were no stress, blew than average stress, average stress, more than average stress, and tremendous stress. Hours working or volunteering working were measured by asking the participant "How many hours a week do you volunteer or work?" Responses were 0 hours, 1-9 hours, 10-19 hours, 20-29 hours, 30-39 hours, and 40 or more hours.

Situation

In the context of SCT, the situation construct is an individual's perception of the place, time, and physical characteristics of the activity (Glanz et al., 2002). Unlike the environment construct, which is described afterward, the situation underlines the cognitive or mental process of evaluating the environment (Parraga, 1990). Four items assessed students' perception of the campus/housing safety level. The questions intended to examine the extent to which students

perceived their environment to be safe. For example, “Do you feel safe in the community surrounding this school (nighttime)?” A four-point Likert scale was offered to assess students' perceived safety ranging from “Not safe at all” to “Very safe.” The four items were combined to obtain a composite construct of perceived safety. The composite had an appropriate internal reliability score (Cronbach’s Alpha = 0.78).

Environment

The environment describes the external circumstances that impact a person's behavior (Redding et al., 2000). SCT specified two types of environments: social and physical. In the current study, only the physical type is incorporated into the model. Among college-aged students, the level of PA can be influenced by where students live (Shaffer et al., 2017). Thus, residing on- campus or off-campus is one crucial determinant of PA. In the NCHA survey, residency was determined by offering two: responses on-campus or off-campus housing.

Control variables

Prior literature has offered insight into potential demographic variables such as age, gender, race/ethnicity, and weight (Edwardson et al., 2014). Therefore, such indicators were included in the hypothesized model. The aim was to ensure identified associations were accounted for and protect against confounding and mediation effects. The control variables included in the model were student's age, gender, race/ethnicity, general health, perceived weight, and estimated Body Mass Index (BMI).

Analytical Processes

The author conducted a series of multilevel logistic regressions to estimate the impact of selected potential indicators on the outcome variable (i.e., PA among college-aged students). The aim was to examine the relationship between PA and student-level factors, quantify the magnitude of the associations, and assess the fit of the proposed model.

Data analysis and model estimation were performed using Hierarchical Linear Modeling (HLM) Package (Scientific Software International, 2017). The software is well-recognized as the leading statistical software for HLM (Raudenbush et al. 2017). In particular, the most recent version (i.e., HLM 7) offers several advantages over other statistical packages. HLM 7 provides multiple capabilities such as an intuitive environment for model specification, straightforward approach to creating more than 2-level models, broad estimate options, combined likelihood ratio hypothesis testing, visual and graphics options, and heterogeneous HLM management tools (Garson, 2012).

The logistic HLM model was chosen as the method of analysis due to the nature of the outcome variable. The study's dependent variable was dichotomized to measure participants who met the PA guidelines and those who did not. Dichotomized variables follow a Bernoulli distribution and thus fail to meet the normality distribution assumption required to implement an Ordinary Least Squares (OLS) Regression (Kleinbaum & Klein, 2010). Due to such violation, the logistic regression model with its capacity to accommodate different distributions was employed for this analysis.

Prior to conducting the analysis, composite independent variables measured by several items were examined to determine the construct's internal consistency or reliability, which assumes that items measuring the same construct are positively correlated (Kimberlin & Winterstein, 2008). Descriptive procedures and reliability estimates were obtained using SPSS version 22.0 (SPSS, Inc. Chicago, IL). The significant level for all performed statistical tests was specified as $p < .05$.

Missing Data

Appropriate data management improves the integrity of the data and ensures well-estimated findings. Thus, high rates of missing cases pose a great risk for analyzed data. If left untreated, missing data can lead to substantial miscalculation errors, which produces misestimated findings. Therefore, proper management of missing data is critical to ensure reliable and accurate results.

In the current study, the author performed the default listwise deletion of cases with missing data. The listwise deletion method is appropriate if the proportion of the missing data is less than 10% (Bennett, 2001). The total respondents who completed the survey were 26,804 students. Upon conducting a missing data analysis, the range of missing values per variable varied considerably. The variable "height" had the highest number of cases with missing values (n = 1,386), representing 5.2% of the total responses. Since all the variables had missing data of less than 10% of their total cases, the author applied the listwise deletion approach. The sample size after the listwise deletion was 23,183 students. Additionally, no significant differences were identified between deleted cases and retained cases in terms of the dependent variable, independent variables, and control variables.

Dependent Variable Transformation

The study's dependent variable was dichotomous and followed the Bernoulli distribution. In the framework of the Generalized Linear Modeling (GLM), the Bernoulli distribution can be modeled by a logistic regression equation. In the equation, a link function was provided to log-transform the binary variable probabilities (McCullagh & Nelder, 1989).

$$ln\ (\pi/(1-\pi)) = \alpha+\beta X$$

In the analysis output, regression coefficients were transformed to odds ratios to enable the interpretation of calculated estimates. The odds ratio of the dependent variable were obtained by taking the exponent of the antilogarithm of the logistic regression coefficients.

$$\text{Odds Ratio } (OR) = e^{\beta}$$

In the exponentiated coefficients (the Odds), a value of one keeps the odds unchanged; a value greater than one raises the odds of a change in the outcome variable; and a value less than one reduces the odds (Pampel, 2000). The coefficients were interpreted as the dependent variable odds of occurrence for a one-unit increase in the independent variable. For continuous independent variables, subtracting one from each odds value and multiplying by 100 produced the percentage of change in the odds of the dependent variable. In dummy variables, the Odds was interpreted as the ratio of odds in comparing the dummy variable with the reference group (Pampel, 2000).

Although odds ratio coefficients help in determining the impact of predictors on an outcome, they fail to make coefficients comparable since the standard deviation between the coefficients varies. The study's odds ratio coefficients were standardized by multiplying the coefficients by their standard deviation and then computing the exponential product to enable comparisons between coefficients (Garson, 2012).

Model Specifications

In the current study, model Specifications were based on the main research questions. The assumed association was hypothesized to be linear and to fit a logistic model with multiple specifications.

Null Model

The first step in the model specification process was to create the null model. The specification of the null model served two crucial purposes. First, the null model was the basis

for computing the Inter-Class Correlation (ICC), a calculated statistic to determine the need for multilevel modeling. Second, the findings output of the null model contained the deviance statistic (*-2LL*) and regression coefficients, which were utilized as a baseline for model cross-comparisons. Additionally, the null model assisted in identifying the extent of college effect on the mean of PA among college-age students. In other words, the null model addressed the question, "Is there a college effect on the intercept of PA among college-aged students?" Thus, since the structure of the data was nested, it was prudent to start with creating the null model, which is illustrated in the following equations:

Level 1: $Prob\ (PAREQ_{ij}=1) = \phi_{ij;}\ \log\ [\phi_{ij}/\ (1 - \phi_{ij})] = \eta_{ij}$; and $\eta_{ij} = \beta_{0j}$

Level 2: $\beta_{0j} = \gamma_{00} + u_{0j}$

The level-1 intercept term (β_{0j}), is a function of the random intercept term in level-2 (γ_{00}) and the level-2 residual (u_{0j}).

Random Intercept Regression Model

The author specified a random intercept regression model to examine primary student-level variables and enable the intercept of PA to be random between colleges. The logistic HLM model included 15 independent variables: age, race, gender, perceived weight, weight loss intention, BMI, interest in PA information, received PA information, current residence, environment safety, sleep quality, stress level, hours working, hours volunteering. The level-2 grouping variable (college) remained random to allow for variability of PA between institutions.

Tests of Significance

The coefficients test of significance identified coefficients' values that differ significantly from zero. However, the test of significance in the logistic model is distinguished from that in OLS regression. In the logistic regression framework, the magnitude of the regression coefficients relative to its standard error offers the ground for testing the significance (Hosmer et

al., 2013). The Wald statistic was used to examine coefficients in independent variables. Such a test was proven robust for even small samples (Hosmer et al., 2013). However, the Wald statistic may lack precision with large absolute values for logistic regression coefficient (Long et al., 2006). Alternatively, a comparison between the log likelihood ratio for potential models can test for significance. Both procedures were employed by the author to test the significance of the analyzed models. To estimate the models parameter the default setting, restricted maximum likelihood estimation, was used.

Results

The sample (n = 23,183) varied between institutions (M= 483, *range* = 174 - 1755). Eighty-four percent of the sample (n = 23,183) reported health status as from good to excellent health. The remaining sample reported their health as being from fair to poor. The respondents' average age was 20 years (SD = 1.68). The majority of the sample identified as being females (70%) compared to males (30%). The students racial and ethnic groups were Whites (70%), Hispanics (1.5%), Asian and Pacific Islanders (11%), and Blacks (7%). The majority of the sample were freshmen (29%) with an equal distribution across the middle classification (i.e., 20% sophomores, juniors, and seniors). In terms of interpersonal relationship, the majority (57%) reported they were not in any relationship, 36% reported being in a relationship, and 7% were living together (see Table 3.2).

Institutions Demographic Characteristics

Forty-nine institutions of higher education from around the U.S. self-selected to participate in the survey. More than half (56%) of the universities were classified as public, and 43.3% were private. Based on the location of the university, almost third (32%) were located in the Southern region and only 12.8% located in the western region. Third of the participating universities had more than 20,000 students, and only 8.8% had a small student's population (<

2,500 students). Most (63.2%) of the institution were in cities; half were located in town; 1.8% were in rural community areas (See Table 3.3).

Random Intercept Null Model

The null model intercept variance (u_0) was obtained by allowing the intercept to be random to investigate the model intercept variance. In the final component variance results, the intercept variance of the outcome variable, average of students who met the PA guideline, was significant ($u_0 = .08$, $SD = 0.29$, $\chi 2 = 448.51$, $p < .001$). The average of students who met the PA guideline was obtained ($M = .43$, $SD = .02$). Some universities showed an extremely low PA level (13%); others exhibited a relatively high PA level (57%). Confirming the large difference in PA between institutions, the variance of the intercept (u_0) was statistically significant. The deviance of the model was obtained ($-2LL = 33149.42$). This statistic served as the basis of comparison with other multi-indictor models.. These findings suggested the averages of PA levels between universities were significantly different, an indication of the existence of a college effect on PA. The ICC for the null model was calculated to determine the extent of the discrepancy between level-1 and level-2 variances. The ICC was statistically significant ($ICC = .75$).

Random Intercept Regression Model

The effectiveness of the specified model in explaining the variation of PA level compared to the null model was examined. The findings of the test were statistically significant (chi-square (χ^2) = 28.34, $p < .001$) indicating better model fit compared with the null model. In the final component variance results, the intercept variance of the outcome variable, average of students who met the PA guideline, was statistically significant ($u_0 = .05$, $SD = 0.22$, $\chi 2 = 298.57$, $p < .001$).

Most of the predictors in the model significantly influenced PA among college-aged students. Meeting the PA guidelines was positively associated with students' knowledge about PA (*OR* = 1.32, $p < .001$), students' interest in information about PA (*OR* = 1.14, $p < .001$), intention to lose weight (*OR* = 1.41, $p < .001$), perceived body weight (*OR* = 0.79, $p < .001$), perceived level of stress (*OR* = 0.85, $p < .001$), sleep quality (*OR* = .92, $p < .001$), gender (*OR* = 1.41, $p < 0.001$), Race (Black) (*OR*= .78, $p < 0.001$), and current residence (living with parents/guardian) (*OR* = .73, $p < .001$). For the received PA information variable (*OR* = 1.3), the odds of meeting the PA guidelines was estimated to be 30% higher in students who reported receiving such information than students who did not. In terms of participant's race, the odds of meeting the recommended PA guidelines were 22% and 17% lower in Black and Hispanic students, respectively, compared to White students. In other words, about 78 Black college-aged students met the PA guidelines per 100 White students holding all other variables constant.

After calculating the standardized odds ratio coefficients among continuous predictors, perceived safety had the most substantial positive impact. One standard deviation unit increase in reported safety improved the odds of meeting PA guidelines by 7%. On the other hand, the more substantial negative impact among the continuous predictors was perceived body weight and level of perceived stress with 15% and 13% decrease, respectively, in the odds of meeting PA guidelines with one unit increase in their standard deviation. The results of the logistic coefficient, *p*-value, odds ratio, and confidence intervals are listed in Table 4.

Discussion

This study sought to examine the determinants of PA level among college-aged students using secondary data provided by the American College Health Association-National College Health Assessment (ACHA-NCHA), a comprehensive survey conducted nationwide once every

year since 2000 (ACHA, 2013). The assessed survey students perceived attitudes, lifestyle, and patterns of several college-related health behaviors. To adequately cover the wide range of such behaviors, more than 300 items were designed. Most items were extracted from multiple national health questionnaires such as the Harvard College Alcohol Study (Wechsler & Nelson, 2008), and the CDC's College Health Risk Behavior Survey (Douglas et al., 1997). The wide range of items were intended to cover seven key college health domains: (1) health, health education, and safety, (2) alcohol, tobacco, and drugs, (3) sex behavior, perceptions and contraception, (4) weight, nutrition and exercise, (5) mental and physical health, (6) impediments to academic performance, and (7) demographics. (ACHA, 2013).

The number of students who completed the survey was 23,183 students, form which 70% were female. The wide gap in gender's response rate to national surveys was noticed in the literature. For instance, Porter et al. (2004) conducted an extensive analysis of college students' response rate in national surveys. Their findings indicated a constant decline in male participation and higher female response rate. Such results were supported by others (Korkeila et al., 2001; Sax et al., 2003; Underwood et al., 2000). Another explanation of the gender inequality in surveys' response rate was the rise of female enrollment rate with current estimates reporting that 56% of undergraduate students are females (NCES, 2014). In addition to the prominent female participation, most of the participants were White (70%), and only 7% and 11.5% were Black and Hispanics, respectively. These findings agreed with other studies focused on college-aged students (Dey, 1997; Johnson et al., 2002). However, the racial demographics of the study were different from The National Center for Education Statistics data, which indicated White students represented 55% of overall college-aged students while Black and Hispanic students contributed to 13% and 16%, respectively (NCES, 2016).

Twenty-nine percent of the sample reported engaging in the recommended four days or more of moderate PA, while 24% indicated exercising zero days. Rates were even lower in meeting vigorous PA and strength training guidelines with 43% of the total respondents indicated zero days of vigorous PA and that 56% reported zero days of strengthening workout. The dichotomous variable of PA, in which the three items of PA were combined to determine the sufficiency of meeting the federal guidelines for adults, showed unsatisfactory findings. From the sample, 55% failed to meet the minimum recommendations to obtain the optimum health benefits of PA. Previous studies reported lower rates of students who failed to meet the PA guidelines. Keating et al. (2005) conducted a meta-analysis to examine the prevalence of PA among college-aged students and found the average rate of failure to meet PA guidelines to be 40% compared to 36% among the general population. Other systematic-review studies estimated the range of PA levels to be between 40% and 50% (Leslie et al., 2000; Pinto & Marcus, 1995).

Results of the logistic regression model showed several significant findings. Among demographic indicators, age, gender, and race of the students were powerful determinants of PA level. Males were more likely to meet the PA guidelines than females. Such finding is in accord with earlier studies (Keating et al.,2005). Despite having a higher intention to lose weight, females were less active than males. Such paradox was observed in the literature (Sax and Harper, 2007). Females with an intent to lose weight usually employ other methods than engaging in PA. For instance, a national study found that females tended to manage their weight by limiting their food intake while males engaged more in PA (Middleman et al., 1998). In addition to gender, participant's race had a significant association with PA level. Compared to White students, Black and Hispanic students were less likely to meet the minimum PA guidelines. The discrepancy in PA prevalence between White students and other racial minorities

has been reported consistently in the research (Eaton et al., 2008; Brodersen et al., 2007). A significant difference in the achievement of sufficient PA levels was observed by age, which has been previously documented (Whitt-Glover et al., 2009).

The estimated impact of the SCT constructs varied in its magnitude and significance. The most substantial observed impact was from the environment. A student's perception of safety in their residence significantly influenced their engagement in PA and meeting the recommended guidelines. This is not surprising considering the mounting body of research demonstrating the significant impact of higher-level determinants of PA (Booth et al., 2001; Sallis, J., & Owen, 2002; Owen et al., 2004). Thus, assessing and alleviating safety concerns among college students must be a priority. Universities aiming to promote PA level among their students should develop plans and allocate funds to enhance perceived safety among students. Unfortunately, most of the current road systems are designed for vehicles transportation with less regard to pedestrians (Retting et al., 2003). Walkability can be improved by providing proper sidewalks, increasing street lightings, and reducing the impact of crime. Most of these changes can be established by creating organizational-level policies. Therefore, to make engaging in PA more accessible, universities should strive to assess their environment and address safety-related factors.

Limitations

Despite the significance of the findings, there were some limitations. Some of the variables were defined generally and not specifically. For instance, safety as a broad term includes fear of crime, road traffic accidents, air pollution, and other environment-related concerns. However, in the NCHA II survey, the meaning of the term safety was left up for the participant to interpret. Additionally, some of the independent variables were operationally measured using one item with a dichotomous response. While such measurement tool tends to be

efficient and reduces participants' fatigue form long surveys (Porter et al., 2004), it could psychometrically diminish the variable validity and reliability (Carmines & Zeller, 1979). Thus, future research should enhance questionnaires accuracy and validity by designing composites with greater psychometric properties. The data obtained relied on a self-reported questionnaire, which posed a higher risk of diminished validity in measuring the exact score of studied variables (Marsh et al.,1994). However, PA self-reported items are valid and reliable. In one study, the convergent validity of the three-dimension PA construct was cross-validated with maximal oxygen uptake (VO2 max), accelerometers, observations, and pedometers. The findings showed satisfactory psychometric values (Tudor-Locke et al., 2002). Despite the encouraging results of PA instruments' validity, future studies should attempt to directly measure PA intensity, duration, frequency, and type of behavior. Direct tools to measure PA include advanced sensor devices, pedometers, and heart rate monitors (Ainsworth et al., 2015).

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Table 3.1

Variables Used to Predict PA level among College Students

Variable	Question number	Question on NCHA II	Response Options
General health	1	How would you describe your general health?	Excellent; Very good; Good; Fair; Poor; Don't know
Age	46	How old are you?	00 – 99
Gender	47	What is your gender?	Male; Female; Transgender
Year in school	51	What is your year in school?	1st year undergraduate; 2nd year undergraduate; 3rd year undergraduate; 4th year undergraduate; 5th year or more undergraduate; Graduate/ professional; Not seeking a degree; Other
Race	54	How do you usually describe yourself?	White; Black or African American; Hispanic or Latino/a; Asian or Pacific Islander; Am Indian, Alaskan Native, or Native Hawaiian; Biracial or Multiracial; Other
Received PA information	2A7	Have you received information on Physical Activity from your college or university?	Yes; No

Table 3.1 Continued

Variable	Question number	Question on NCHA II	Response Options
Interest in PA information	3A9	Are you interested in receiving information on Physical Activity from your college or university?	Yes; No
Safety	7	Do you feel safe on this campus (daytime)? Do you feel safe on this campus (nighttime)? Do you feel safe in the community surrounding this school (daytime)? Do you feel safe in the community surrounding this school (nighttime)?	Not safe at all; Somewhat unsafe; Somewhat safe; Very safe
Estimated average Body Mass Index (BMI)		This figure incorporates reported height, and weight to form a general indicator of physical health	<18.5 Underweight; 18.5-24.9 Healthy Weight; 25-29.9 Overweight; 30-34.9 Class I Obesity; 35-39.9 Class II Obesity; ≥40 Class III Obesity
Perceived weight	26	How would you describe your weight?	Very underweight; Slightly underweight; About the right weight; Slightly overweight; Very overweight
Weight management intention	27	Are you trying to do any of the following about your weight?	I am not trying to do anything; Stay the same weight; Lose weight; Gain weight
Stress	37	Within the last 12 months, how would you rate the overall level of stress you have experienced	No stress; Less than average stress; Average stress; More than average stress; Tremendous stress

Table 3.1 Continued

Variable	Question number	Question on NCHA II	Response Options
Sleep quality		In the past 7 days, how often have you awaken too early in the morning and couldn't get back to sleep?; how often have you felt tired, dragged out, or sleepy during the day?; how often have you gone to bed because you could not stay awake any longer?; how often have you had an extremely hard time falling asleep?	0 days - 7 days
Housing	58	Where do you currently live?	Campus residence hall; Fraternity or sorority house; Other college/university housing; Parent/guardian's house; Other off-campus housing; Other
Hours working	60	How many hours a week do you work for pay?	0 hours; 1 - 9 hours; 10 - 19 hours; 20 - 29 hours; 30 - 39 hours; 40 hours; more than 40 hours

Table 3.2

Students Demographic Characteristics

Variable	Percentage (%)
Gender	
Male	29.7
Female	70.3
Age	
18-19	44.7
20-21	37.3
22-23	13.9

Table 3.1 Continued

Variable	Percentage (%)
Year in school	
1st year undergraduate	29.2
2nd year undergraduate	20.8
3rd year undergraduate	20.5
4th year undergraduate	18.4
5th and more	4.7
Race/ethnicity	
White	70.5
Black or African American	6.8
Hispanic or Latino	11.5

Table 3.2 Continued

Other	8.2
Relationship status	
Not in a relationship	56.7
In relationship, not living together	36.3
In relationship, living together	6.9
Marital status	
Single	96.2
Married	2.4
Other	1.6
General health	
Excellent	11.8
Very good	38.2
Good	34.4
Fair	13.4
Poor	2.1
BMI classification	
Underweight	5.1
Desired weight	60.3
Overweight	22.1
Obese	12.4
Meeting PA guidelines	
Met the guidelines	44.9
Fail to meet the guidelines	55.1

Table 3.3

Institutions Demographic Characteristics

Campus Characteristic	Percentage (%)
Type of institution	
Public	56.6
Private	43.3
Location of campus	

Table 3.3 Continued

Midwest (IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, WI)	28.1
South (AL, AR, DE, DC, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, WV)	32.1
West (AK, AZ, CA, CO, HI, ID, MY, NV, NM, OR, UT, WA, WY)	12.8
Campus Size	
< 2,500 students	8.8
2,500 – 5,000 students	13.4
5,000 – 9,999 students	31.3
10,000 – 19,999 students	14.1
20,000 students or more	32.4
Campus Setting	
Very large city (population over 500,000)	18.9
Large city (population 250,000-499,999)	17.3
Small city (population 50,000-249,999)	27
Large town (population 10,000 – 49,999)	24.4
Small town (population 2,500-9,999)	10.6
Rural community (population under 2,500)	1.8

Table 3.4

Logistic Coefficient and odds ratios of the impact of independent variables on PA

Variable	Logistic Coefficient	*p*	Odds ratio	Confidence interval	
				Lower	Upper
Age	-0.04	<0.001	0.96	0.94	0.98
Gender	0.27	<0.001	1.31	1.23	1.39
Race/ethnicity					
Black or African American	-0.24	<0.001	0.78	0.70	0.88
Hispanic or Latino	-0.19	<0.001	0.83	0.76	0.91
Asian or Pacific Islander	-0.36	<0.001	1.04	0.97	1.12
Table 3.4 Continued					
Received Information about PA	0.26	<0.001	1.30	1.23	1.37
Interest in Information about PA	0.10	0.002	1.10	1.04	1.17
Perceived body weight	-0.23	<0.001	0.79	0.74	0.84
Intention to lose weight	0.35	<0.001	1.42	1.33	1.51
Body Mass Index (BMI)	-0.01	<0.001	0.99	0.98	0.99
Level of stress	-0.16	<0.001	0.86	0.82	0.89
Sleep quality	-0.08	<0.001	0.92	0.89	0.95
Current residence					
Fraternity/Sorority house	0.05	0.66	1.05	0.85	1.29
Parent/Guardian's home	-0.31	<0.001	0.73	0.67	0.80
Other off -campus housing	0.04	0.26	1.04	0.97	1.12
Working hours	-0.05	<0.001	0.95	0.93	0.97
Volunteer hours	0.17	<0.001	1.19	1.13	1.24
Environment safety	0.03	<0.001	1.03	1.01	1.04

CHAPTER IV

DETERMINANTS OF PHYSICAL ACTIVITY: A MULTILEVEL ANALYSIS OF THE AMERICAN COLLEGE HEALTH ASSOCIATION SURVEY

Introduction

In 2016, the World Health Organization (WHO) cited physical inactivity as one of the primary modifiable risk factors for illness and disease along with obesity and tobacco (WHO, 2016). To curb the alarming increase in physical inactivity, the WHO emphasized the need to promote physical activity (PA) and established an objective to raise PA by 10% in 2025 (Reis et al., 2016). There is a substantial evidence for the benefits of regular PA in preventing certain chronic diseases (e.g., diabetes, coronary heart disease, stroke, osteoporosis, high blood pressure, cardiovascular disease; Blair et al., 1996), protecting against some types of cancer (e.g., breast, colon; Lee, 2003), controlling obesity (Wareham et al., 2005), enhancing overall well-being (e.g., improved quality of sleep, diminished risk of depression and mood disturbances; Paluska & Schwenk, 2000), and improving cognitive capabilities (e.g., enhanced memory, increased cognitive energy; Ruscheweyh et al., 2011). PA positive outcomes are far-reaching; they go beyond the individual and extend to the person's community, society, and environment (Blair et al., 2009). Thus, programs and interventions designed to promote PA have become a critical component to prevent adverse health consequences and improve people's quality of life (Bonevski et al., 2014). As in most public health agendas, increasing participation in regular PA has been a primary goal of Healthy People 2020 (HHS, 2010).

Healthy Campus 2020, an adjacent document to Healthy People 2020 (U.S. Department of Health and Human Services, 2000), has emphasized the importance of educating college students, and creating a campus environment conducive to health and wellbeing (ACHA, 2010).

The rationale for developing Healthy Campus 2020 was in part due to the escalating rate of sedentary lifestyle among college-aged students. In 2010, 48% of college students failed to meet the minimum requirement of aerobic PA and only 37% participated in muscle-strengthening activities (ACHA, 2010). The Healthy Campus 2020 objective was to reach 53% by 2020 (i.e., 10% increase).

The prevalence of engaging in regular PA declines rapidly after adolescence. Bary and Born (2004) followed a cohort of students, from high school to college, to track their PA levels and determine possible PA patterns. Their findings indicated a decrease in the percentage of students meeting the PA guidelines from 66% in the last two months of high school to 44% in the first two months of college (Bary and Born, 2004). A recent study found a similar pattern with 65% of high school students meeting PA recommendation compared to 38% among college students (CDC, 2017). The steady decline of PA among college students continues even after graduation and later in adulthood, which raises concerns about their current and future health and well-being (Byberg et al., 2009).

Several significant changes accompany students' transition from residing at home to residing on campus. Moving to college is associated with more autonomy over students' PA behavior (Plotnikoff et al., 2015). Because of their stage of life, students tend to underestimate the long-term detrimental impact of physical inactivity (Kattelmann et al., 2014). Additionally, PA can be discouraged by college-related obstacles such as irregular daily schedule, extracurricular activities, work, and social life (Vickers et al., 2004). Despite PA barriers and challenges observed in the college context, universities have an opportunity to cultivate their environment as a leverage to promote PA.

Institutions of Higher Education have the potential to encourage a large segment of society (i.e., college students) to adhere to current PA guidelines. According to the National Center for Education Statistics (NCES, 2018), over the past six years, the enrollment in undergraduate postsecondary institutions rose from 13.2 million to 16.9 million students (i.e., 28% increase). The number is expected to reach 17.5 million students by 2027 (NCES, 2018). The population classified as college graduates is steadily growing, and such group represents a vital segment of the general population (Towne et al., 2017).

Prompted by the pervasive PA health benefits and the potential of universities, PA researchers have been attempting to understand its determinants and identify the most effective approach to promote PA among college-aged students. Despite the differences in previous studies' methods, most of the findings agree on the dominance of higher-level factors. In a comprehensive systematic review, Stone et al. (1998) recommended that future programs should employ social, policy, and environmental level factors to enhance PA among college-aged students. In another systematic-review, Ringuet and Trost (2001) examined the impact of community-level and personal-level determinants and found strong associations between higher-level variables and PA. The widely documented importance of higher-level determinants of PA shifted more investigations to focus on such factors.

Employing theories of health behavior change in the context of PA has been instrumental in designing effective evidence-based interventions. Higher-level factors (e.g., environmental, social) were defined in the PA literature as "barriers," "facilitating conditions," or "contextual influences" (Godin, 1994). Bandura's (1986) Social Cognitive Theory (SCT) defined the role of the environment as a part of a triad along with the behavior and the individual. The exchange and interaction between environmental, personal, and behavioral factors eventually explain human

behavior. However, the extent of such influence varies as it depends on the activity itself, personal factors, and environmental cues. More importantly, Bandura's emphasized the role of the environment and argued that high-level factors override other determinants. Despite the broad support for the multilevel approach to explain and promote PA, there is limited knowledge about the impact of higher-level (i.e., college-level) factors, particularly among college-aged students.

Purpose

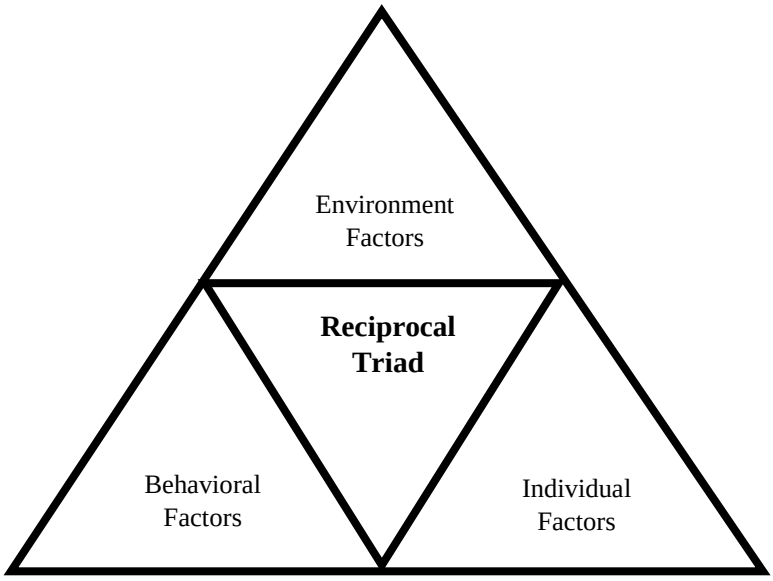
The current study aimed to examine the role of higher-level determinants of PA among college-aged students using the American College Health Association's National College Health Assessment II (NCHA II) survey. Two research questions that guided the study: (1) What are the primary college-level determinants of PA among college-aged students?; and (2) To what extent do the primary college-level determinants impact PA among college-aged students?

Theoretical Framework

Health theories strive to promote preventive health behaviors by influencing behavioral determinants. However, behavior change theories differ in their focus, broadness, and applicability. Some theories focus on individual factors with little regard to external determinants (Miller, 2005). Other theories extend their scope to include personal, social, and environmental factors. The Social Cognitive Theory (SCT) is one of the latter group. Albert Bandura developed SCT in 1986, an era in which behaviorism thinking was dominant (Bandura, 2001). Bandura posits that human behavior is partially determined by a person's past experiences, antecedents, and expectancies (Bandura, 2001). In other words, the principle of operant conditioning, in which negative and positive reinforcements promote behavior change, was insufficient to explain behavior (Miller, 2005). Bandura believes the interplay between a person's thinking process or

"cognitive dialogue," social determinants, and environmental circumstances determine the behavior (Bandura, 1978). SCT focuses on the dynamic loop of interaction between the individual and their surrounding environment (Bandura, 2001). The notion of interchangeability between external and internal factors is the hallmark of CST; this concept is what distinguishes SCT from individual-oriented theories. Bandura coined the term “reciprocal determinism” within a “reciprocal triad” (see Figure 1), in which a behavior is determined by an interactive cycle between a person's behavior and the environment (Glanz et al., 2008).

Figure 4.1 Social cognitive triad



SCT assumes a constant state of reciprocity and interaction between the individual's cognition capabilities, perfumed behavior, and encompassing environment (Bandura, 1986). This fluid, dynamic exchange initiates a unique type of agency, “the emergent interactive agency” (Bandura, 1986). With the reciprocity cycle, individuals are “neither autonomous agents nor

simply mechanical conveyors of animating environmental influences" (1989, p.1175). Thus, human behavior is determined by individual characteristics, social determinants, and environmental cues.

SCT has been widely applied, in health promotion studies and preventive interventions, to evaluate behavioral patterns, explain persistent unhealthy habits, and predict behavior-modifying strategies (Glanz et al., 2008); SCT constructs have been empirically verified and rigorously studied for their explanatory power in several health contexts such as nutrition, weight control, smoking cessation, contraception usage, and exercise participation (Bandura, 1992; Catania, Kegeles, & Coates, 1990; Stretcher, DeVellis, Becker, & Rosenstock, 1986). Compared to other theoretically-grounded studies, interventions guided by SCT constructs were more likely to deliver effective and sustainable behavioral change (Thirlaway & Upton, 2009).

Since its inception, SCT has been beneficial in the field of PA research. SCT offers a multilevel theoretical lens through which complex associations between PA and its determinants can be examined thoroughly. However, in most studies, SCT constructs were adjusted to fit the characteristics distinct to PA. Researchers have long recognized the importance of SCT in PA and emphasized the need to tailor SCT concepts to suit the context of PA (Leivdai, 1993). For instance, Annesi et al. (2011) introduced the coach approach model, a modified form of SCT in which self-efficacy were exchanged with "mood, perceptions of the body, and relations of improvements in those psychological factors." Similarly, Wallace et al. (2000) incorporated constructs from Personal Investment and Stages of Change Model Theory (SCMT) into SCT to better predict PA participation.

Methods

The current study examined the primary determinants of PA level among college-aged students utilizing secondary data from the American College Health Association-National College Health Assessment (ACHA- NCHA II) that reflected the characteristics of the target population (i.e., nationally-represented sample of college-aged students; Krosnick & Fabrigar, 1997). The author used a retrospective cross-sectional design to examine the NCHA II secondary data, administered and collected in the fall 2016 semester by ACHA.

National College Health Assessment

The ACHA-NCHA II is a comprehensive survey conducted nationwide every year since 2000. NCHA II has an exhaustive health profile regarding college students' behaviors and attitudes (ACHA, 2013). The ACHA recruited an interdisciplinary team of college health professionals to develop a comprehensive instrument for measuring students' health indicators. The first version of the NCHA consisted of more than 300 items and assessed a multitude of health behaviors, perceptions, and habits of college students (ACHA, 2013). Several of the survey's items represent multiple national health questionnaires, such as the Harvard College Alcohol Study (Wechsler & Nelson, 2008) and the Centers for Disease Control and Prevention's College Health Risk Behavior Survey (Douglas et al., 1997). All designed items were psychometrically examined using experts' feedback, pretest-posttest assessment, and validity methods (ACHA, 2013). In 2008, the health experts continued the modification procedures and revised the NCHA survey. The process resulted in rewording several measure items, adding items to measure health constructs accurately, and deleting some unnecessary items. The updated version was reevaluated to assess reliability and validity and renamed the NCHA II.

Since the initial data collection, there has been an increase in the number of colleges and universities that participated in the NCHA study. For instance, 832 higher education institutions

completed the survey before 2008 compared to 937 higher education institutions after 2008 (ACHA, 2013). The NCHA II measured seven critical health domains (1) health, health education, and safety; (2) alcohol, tobacco, and drugs; (3) sex behavior, perceptions, and contraception; (4) weight, nutrition, and exercise; (5) mental and physical health; (6) impediments to academic performance; and (7) demographics (ACHA, 2013).

The questionnaire offers college health professionals and administrators the appropriate evidence and knowledge of students' current health habits, behaviors, and perceived attitudes. The information generated by the NCHA II has been used to tailor programs by college health educators and administrators (ACHA, 2013). For example, Kernan et al. (2011) examined mental health patterns among college-aged students using NCHA II data while health researchers developed tailored- and evidence-based health promotion interventions (Bulmer et al., 2010; Becker et al., 2008; Blosnich et al., 2010). For college administrators, the findings from the NCHA II created a comprehensive college-related health strategy that helped in the allocation of campus resources.

Data Collection

Higher education institutions were self-selected to participate in the NCHA II. The survey was administered to respective students enrolled in the colleges and universities participating in the NCHA II. The procedures involved completing a participation form, submitting a mandatory student's demographic survey, and mailing a survey order form (ACHA, 2013). Based on selected options, the survey can be web-based, paper-based, or both. If the desired instrument was web-based, a spreadsheet of selected sample's email addresses, letter of consent, a reminder letter, and institutional IRB approval letter had to be submitted. If an institution selected the paper-based format, the IRB approval letter had to be submitted before

data collection. Once completed and collected by the institutions, the surveys were returned to the ACHA, which either scanned the paper-based surveys or saved the electronic data on a secured website. All data types, web-based and paper, were scanned into SPSS to create data codebooks and files, which was then sent back to the institution on a CD (ACHA, 2013).

The within-institution sample was selected through a randomized-selection process. The paper-based followed the randomized process by creating a pool of classrooms in the respected semester. After the classroom selection process was completed, students in respective classes represents the sample list (ACHA, 2013). Subsequently, the randomized emails were dispatched to the ACHA, which ensured the privacy and confidentiality of the received information. The ACHA emailed potential participants with an invitation link which included a distinct identification number. The period of implementing the web-based survey ranged between two to four weeks in which several reminder notification emails were sent for non-respondents (ACHA, 2013). Students' participation was enhanced with institutions utilized incentives procedures, such as games tickets to athletic events, course credits, or monetary incentives (e.g., cash or gift cards; ACHA, 2013). The incentives procedures increased the response rate, which is beneficial in enhancing the integrity of the data by reducing the amount of missing data (Krosnick et al., 1997).

For the current study, the most recent and available data were requested by the author. The data represented a survey completed in the fall semester of 2016 and contained approximately 48,000 participants from 92 institutions of higher education. The average response rates were different between the web-based and paper-based surveys. The response rate for the paper-based survey was 81%, while the web-based survey had a 19% response rate. The low response rate in the web-based survey is typical in health assessment surveys on the general

population (Musich et al., 2001). Approval for conducting the study was granted by the Texas A&M University Institutional Review Board.

Inclusion Criteria

The NCHA II instrument contained more than 300 items to measure college-related health behaviors. To accurately assess such indicators, specific constructs were developed by the ACHA. In the current study, the author selected constructs related to the study's main research questions and the proposed theoretical framework. The variables' selection process was guided by the Social Cognitive Theory (SCT). Inclusion criteria were established by the author to ensure agreement between the analyzed data and the research's questions. Among all NCHA II participants who completed the survey, only healthy students aged 18-24 years were included since the author research interest was on the impact of PA determinants among this particular age group (Simons et al., 2012). College-aged students share several personal, social, and economic factors such as the high rates of sexually transmitted diseases or infections (Centers for Disease Control and Prevention [CDC], 2014) and unprecedented increase rates of unintended pregnancy (Brunner Huber & Ersek, 2011). Based on the inclusion criteria, the study sample size yielded to 23,183 participants.

Dependent Variable

The outcome variable was meeting the PA recommended guidelines. The recommendations were established by federal and national health organizations to encourage adults to meet two categories of PA (The American College of Sports Medicine [ACSM], 2018). The first category of PA is aerobic fitness. The guidelines required 150 minutes per week of moderate aerobic PA or 75 minutes per week of vigorous aerobic PA. Activities such as walking or biking were considered moderate PA and intense activities such as jogging and swimming were viewed as vigorous PA. The second category of PA was strength training. Individuals who participated in

pushups, sit-ups, or weight-lifting were engaging in strength training activities. Three domains operationally defined the PA construct. To ensure each domain was measured appropriately, three items were designed to assess students PA. The NCHA II asked participants "On how many of the past 7 days did you":

a. Do moderate-intensity cardio or aerobic exercise for at least 30 minutes?

b. Do vigorous intensity cardio or aerobic exercise for at least 20 minutes?

c. Do 8-10 strength training exercises for 8-12 repetitions each?

Respondents were instructed to select a frequency response ranging from 0 – 7 days. The items were designed to cover three dimensions of the PA construct; these dimensions were specified in the definition of PA behavior (ACSM, 2018). The study's dependent variable was then dichotomized to measure participants who met the PA guidelines and those who did not.

Independent Variables

Indicators in the data analysis included both student-level and college-level variables as the study's research questions aimed to investigate the impact on PA among students and their institutions.

Student-level independent variables. To understand the variation in PA level between college-aged students, several independent variables were examined (See Table 4.1).

College-level independent variables. The author obtained college-level variables from their respective student-level variables. Individual's scores on student-level variables were aggregated as proportions or percentages to create college-level variables (See Table 4.2).

Control variables. PA level is correlated with other variables (i.e., control covariates), which might not be of theoretical interest but impact the findings of the analysis. The literature suggested potential demographic variables such as age, gender, race/ethnicity, and weight (Edwardson et al., 2014). Incorporating the control variables ensured identified associations were

accounted for and protected against potential confounding and mediation effects. Failing to account for confounding variables raises concerns about the study's internal validity (Garson, 2014). The control variables included in the model were student's age, gender, race/ethnicity, general health, and estimated Body Mass Index (BMI).

Measures

The complexity of the PA behavior stems in part from the heterogeneity of its indicators, observed in each level of influence (Dishman, 1988). Primary PA indicators were found in several domains including demographic factors, cognitive variables, skills capabilities, social determinants, environmental cues, and characteristics of the behavior itself (Sallis et al., 1992). The current study's variables were selected from the NCHA II survey based on SCT. The hypothesized model was developed to include personal, social, and environmental variables that were considered by the author and previous studies to be related to SCT constructs.

Behavior Capability

The construct of behavioral capability emphasizes the role of knowledge and skills in determining human behavior. A person's exposure to information that promotes an active lifestyle can influence his/her cognitive process as it evaluates the pros and cons of PA. Additionally, learning about PA can enhance skills, capabilities, and subsequently their self-efficacy to engage in PA (Bandura, 1989). Among college students, regular PA is likely to increase as knowledge of PA benefits, methods, and guidelines is improved (Redding et al., 2000). In the current study, the behavioral capability construct was assessed by measuring the level of PA information a student received from his or her respective university. Students were asked a yes-or-no question to determine if such information was received. In addition, students were asked a yes-or-no question about their interest in receiving such information. On the college-level, PA knowledge provided by institutions plays a critical role in shaping students'

attitudes and willingness to engage in PA. In the current study, to obtain a college-level indicator, PA information was aggregated by computing the percentage of students who received information about PA from their respective institution.

Vicarious Experiences

Social models, in which a person observes others engaging in specific health behavior, can create a vicarious experience that can heighten confidence and self-efficacy (Bandura, 1998). Beyond providing a social standard through which a person can indirectly compare capabilities, modeling can offer an implicit way of spreading information between individuals, teaching effective skills, and managing external demands (Bandura, 1998). Thus, behavior can be effectively regulated by the predominant social norms, which further are enhanced by performing the behavior, subsequently creating a positive dynamic loop (Sallis & Owen, 2002). Collectively, the prevalence of PA within college can be an effective, influential factor. In the current study, a college-level variable was developed to assess the proportion of students, within each institution in the sample, who met the recommended guidelines.

Perceived Barriers

Perceived barriers are obstacles for taking a predetermined action. Based on the nature of the performed behavior, deterrents can also originate from negative consequences (Rahn, 2014). Perceived obstacles vary in their extent from inconvenience to unbearable pain. Additionally, barriers can be tangible, such as financial cost, or intangible, such as embarrassment (Hayden, 2013). In this study, the examined barriers focused on college-related obstacles in PA. Three constructs were identified as potential barriers: sleep quality, level of stress, and hours working or volunteering. Sleep quality was measured by asking the participant “In the past 7 days, getting enough sleep to feel rested?” Responses were 0 days, 1-2 days, 3-5 days, and 6 or more days. Level of stress was measured by asking the participant “Within the last 12 months, how would

you rate the overall level of stress experienced?" Responses were no stress, blew than average stress, average stress, more than average stress, and tremendous stress. Hours working or volunteering working were measured by asking the participant "How many hours a week do you volunteer or work?" Responses were 0 hours, 1-9 hours, 10-19 hours, 20-29 hours, 30-39 hours, and 40 or more hours.

Situation

In the context of SCT, the situation construct is a perception of the place, time, and physical characteristics of the activity (Glanz et al., 2002). Unlike the environment construct, which is described afterward, the situation construct underlines the cognitive process of evaluating the environment (Parraga, 1990). In the PA literature, safety was frequently cited as a critical situational factor in regulating PA behavior in college settings (Sallis et al., 1992). Four items assessed students' perception of the campus/housing safety level. The questions assessed the extent to which students perceived their physical environment to be safe. For example, "Do you feel safe in the community surrounding this school (nighttime)?" A four-point Likert scale was offered to measure students' perceived safety ranging from "Not safe at all" to "Very safe." The four items were combined to obtain a composite construct of perceived safety. The composite had an appropriate internal reliability score (Cronbach's Alpha = 0.78).

Environment

The environment contains the external circumstances that impact a specific behavior (Redding et al., 2000). As an essential part of the reciprocal triad in SCT, the environment's role in regulating human behavior is increasingly recognized. Environment cues and demands can act as facilitators or barriers to performing health behaviors (Redding et al., 2000). For instance, living in an environment designed with walking paths, proper lighting, and desirable aesthetics can influence PA (Sundquist, 2011). Among college-aged students, their residence has been

widely cited as the primary factor in determining the level of PA (Shaffer et al., 2017). In the NCHA II survey, current student residence was determined by offering two responses: on-campus or off-campus.

Analytical Processes

The author used Hierarchical Linear Modeling (HLM) based on theoretical interest. The models aimed to address the study's main central questions. The logistic HLM model was chosen as the method of analysis due to the nature of the dependent variable (i.e., dichotomous variable). Data analysis and model estimation were conducted using the HLM package (Scientific Software International, 2017). The software is well-recognized as the leading statistical software for multilevel modeling (Raudenbush et al. 2017). In particular, the most recent version (i.e., HLM 7) offers several advantages over other statistical packages. HLM 7 provides multiple capabilities such as an intuitive environment for model specification, straightforward approach to creating multilevel models, broad estimate alternative options, combined likelihood ratio hypothesis testing, visual and graphics options, and heterogeneous hierarchical linear model's management tools (Garson, 2012).

When data contain a clustering or grouping within its subjects, the likelihood of correlated errors increases dramatically (Garson, 2014). Error correlations (i.e., dependency) between study participants violate a critical assumption in the framework of the ordinary least squares (OLS) regression. The magnitude of the violation is determined by the extent of the dependence between the participants, who often share similar attributes through an underlying grouping identity. The consequences of violating the error independence assumption are detrimental to the study's findings. Correlated errors often produce miscalculated standard errors and parameters estimates (Raudenbush & Bryk, 2002).

The variability in PA among college-aged students was divided based on the number of levels in the specified model. Since the data contained two levels, the variability was decomposed into two components: Level 1 (i.e., within students), and level 2 (i.e., within colleges). Separating the total variability of PA enabled the author to quantify the estimated proportions of the variance associated with each level. For instance, the variation in PA among college-aged students could be explained by differences in PA knowledge among students and safety between institutions.

Before conducting the analysis, composite independent variables measured by several items were examined to determine the construct's internal consistency or reliability, which assumes that items measuring the same construct are positively correlated (Kimberlin & Winterstein, 2008). Descriptive procedures and reliability estimates were obtained using SPSS version 22.0 (SPSS, Inc. Chicago, IL).

Missing Data

Appropriate data management improves the integrity of the data and ensures well-estimated findings. Thus, high rates of missing cases pose a substantial risk that can threaten data reliability and validity. If left untreated, missing data can lead to significant miscalculation errors that eventually produce misestimated statistics. Therefore, proper management of missing data is critical to ensure consistent and accurate results.

In the current study, the author performed the default listwise deletion of cases with missing data. The listwise deletion method is appropriate if the proportion of the missing data is less than 10% (Bennett, 2001). The total respondents who completed the survey were 26,804 students. Upon conducting the missing data analysis, the range of missing values per variable varied considerably. The variable "height" had the most significant number of cases with missing values (n = 1,386), representing 5.2% of the total responses. Since all the variables had missing

data of less than 10% of their total cases, the author applied the listwise deletion approach. The sample size after the listwise deletion was 23,183 students. Additionally, no significant differences were identified between deleted cases and retained cases in terms of the dependent variable, independent variables, and control variables.

Dependent Variable Transformation

The study's dependent variable was dichotomous and followed the Bernoulli distribution. In the framework of the Generalized Linear Modeling (GLM), the Bernoulli distribution can be modeled by a logistic regression equation. In the equation, a link function was provided to log-transform the binary variable probabilities (McCullagh & Nelder, 1989).

$$ln\ (\pi/(1-\pi)) = \alpha+\beta X$$

In the analysis output, regression coefficients were transformed to odds ratios to enable the interpretation of calculated estimates. The odds ratio of the dependent variable was obtained by taking the exponent of the antilogarithm of the logistic regression coefficients.

$$\text{Odds Ratio } (OR) = e^{\beta}$$

In the exponentiated coefficients (the odds ratio), a value of one keeps the odds unchanged; a value greater than one raises the odds of a change in the outcome variable; and a value less than one reduces the odds (Pampel, 2000). The coefficients were interpreted as the dependent variable odds of occurrence for a one-unit increase in the independent variable. For continuous independent variables, subtracting one from each odds value and multiplying by 100 produced the percentage of change in the odds of the dependent variable. In dummy variables, the odds were interpreted as the ratio of odds in comparing the dummy variable with the reference group (Pampel, 2000).

Although odds ratio coefficients estimate the impact of predictors on an outcome, they fail to make coefficients comparable since the standard deviation between the coefficients varies

(Garson, 2012). The study's odds ratio coefficients were standardized by multiplying the coefficients by their standard deviation and then computing the exponential product to enable comparisons between coefficients.

Model Specifications

HLM, with its advantages of allowing intercepts and coefficients to be random, offers a broad list of model specifications. This feature enables the researcher to develop appropriate models without fear of potential assumption violation. In the current study, three models were specified. To estimate the models parameter the default setting, restricted maximum likelihood estimation, was used.

Random intercept null model. In HLM analysis, the first step in the model specification is to create a random intercept null model (Garson, 2014). This model specifies the intercept of the dependent variable in level-1 as a random effect of the level-2 grouping variable without any indicators at level-1 or level-2. The rationale for initiating the model specification process with the null model is two-fold: (1) The null model serves as the basis for computing the Interclass Correlation Coefficient (ICC); and (2) The model determines the deviance statistic (- *2LL*), used as a baseline for cross-model comparisons.

In the current study, the random intercept null model was used to address the question, "Is there a college effect on the mean of PA among college-aged students?" Thus, the differences between institutions' means of PA were analyzed based on the random effect of colleges at level-2. The two-level model is illustrated in the following equations:

Level 1: Prob ($PAREQ_{ij}$=1) = $\phi_{ij;}$ log [ϕ_{ij}/ (1 - ϕ_{ij})] = η_{ij}; and $\eta_{ij} = \beta_{0j}$

Level 2: $\beta_{0j} = \gamma_{00} + u_{0j}$

The level-1 intercept term (β_{0j}) is a function of level-2 random intercept term (γ_{00}) and residual (u_{0j}). Values of these terms were critical to determining the need for a multilevel analysis due to the structure of the data.

Random coefficient regression model. After examining the impact of colleges on PA intercept, the student-level predictors were added to the model. The goal of the random coefficient regression model was to estimate the odds of the dependent variable based on the function of independent variables at the student-level. Included student-level independent variables were student's age, gender, race/ethnicity, general health, and estimated average Body Mass Index (BMI), weight management intention, received PA information, interest in PA information, safety, stress, sleep quality, housing, hours working, and current residence. The two-level model is illustrated in the following equations:

$$\log [\phi_{ij}/ (1 - \phi_{ij})] = \eta_{ij}$$

Level 1: $\eta_{ij} = \beta_{0j} + \beta_{1j} X_{ij} + r_j$

Level 2: $\beta_{0j} = \gamma_{00} + u_{0j}$

$$B_{1j} = \gamma_{10} + u_{1j}$$

Although the odds ratio coefficients determine the predictors' impact on the outcome variable, such estimates fail to make coefficients comparable since the variables' standard deviation vary. Thus, to enable cross-coefficients comparisons, the odds ratio coefficients were standardized by multiplying the coefficients by their standard deviation and then computing its exponential product.

Full random coefficients model. In this model, also called intercepts-and-slopes-as-outcomes model, both level-1 coefficients and intercepts are modeled by level-2 grouping variable and level-2 independent variables (Hofmann, 1997). Conceptually, the coefficients'

estimates (i.e., intercepts and slopes) for each independent variable at level-1 are allowed to be random to predict the dependent variable variation. Thus, the model is well-designed to estimate the association between independent and dependent variables, by taking into account level-1 and level-2 regression relationships. In the current study, PA among college-aged students was modeled as a function of level-1 and level-2 predictor with allowing the intercepts and coefficients to be random.

Tests of Significance

The coefficients test of significance identified coefficients' values that differ significantly from zero. However, the test of significance in the logistic model is distinguished from that in OLS regression. In the logistic regression framework, the magnitude of the regression coefficients relative to its standard error exhibits the extent of the significance (Hosmer et al., 2013). The Wald statistic was used to examine the estimated coefficients of the study's independent variables. The Wald test was proven robust for even small samples (Hosmer et al., 2013). However, the Wald statistic may lack precision with large absolute values for logistic regression coefficient (Long et al., 2006). Alternatively, a comparison between the log likelihood ratio for potential models can test for significance. Both procedures were employed by the author to test the significance of the analyzed models.

Results

Students Demographic Characteristics

A large sample (n = 23,183) of college-aged students from different U.S. universities (n = 48) participated in the Fall 2016 NCHA II survey. The sample varied between institutions (M= 483, *range* = 174 - 1755). Almost half of the sample (45%) were between 18 and 19 years with a respondents' average age of 20 years (SD = 1.68). The majority of the sample identified themselves as being females (70%). The students racial and ethnic groups were Whites (70%),

Hispanics (1.5%), Asian and Pacific Islanders (11%), and Blacks (7%). More first-year students participated in the study than any other school year: 29% were in their freshmen year, 5% were in their fifth year, and 20% in each sophomore, junior, and senior year. Eighty-four percent of the respondents cited their overall health being between excellent to good; the remaining 15.5% considered their health to be fair to poor. In terms of interpersonal relationship, more than a half (57%) reported they were not in any relationship, 36% reported being in a relationship, and 7% were living together (See Table 4.3).

Institutions Demographic Characteristics

Forty-nine institutions of higher education from around the United States self-selected to participate in the survey. More than half (56%) of the universities were classified as public, and 43.3% were private. By location, almost one-third (32%) of the universities were located in the southern region, 28.1% were in the midwestern region, 27% were in the northeastern region, and only 12.8% were located in the western region. In terms of the number of enrolled students, one-third of the participating universities had more than 20,000 students, and only 8.8% had a small student's population ($n < 2{,}500$ students). Most (63.2%) of the institution were in cities, half were located in towns, and 1.8% were serving rural community students (See Table 4.4).

Random Intercept Null Model

To confirm the need for a multilevel model, the ICC was computed. The estimated ICC was statistically significant ($ICC = .75$). The average reliability of the intercept estimates among the universities showed an acceptable measure (.84). Values lower than .5 reflect an inadequately explained variability in the model (Raudenbush & Bryk, 2002).

Analysis of the random intercept, the average of students who met the PA guideline, indicated a significant variability across institutions' PA means ($M = .43$, $SD = .02$). Some universities showed an extremely low PA level (13%); others exhibited a relatively high PA level

(57%). Confirming the large difference in PA between institutions, the variance of the intercept (u_0) was statistically significant (u_0 = .08, *SD* = 0.29, χ^2 = 448.51, $p < .001$). The deviance of the model was obtained (*-2LL* = 33149.42). This statistic served as the basis of comparison with other multi-indictor models.

Random Coefficients Regression Model

The average reliability of the intercept and slopes estimates showed an acceptable measure (.34). The random coefficients regression model was compared to the null model to determine any improvement. The chi-square test was statistically significant (χ^2 = 28.34, $p < .001$), indicating an improved fit in the random coefficients regression model. To further examine the model fit, the Hosmer Lemeshow method was employed. The Hosmer Lemeshow test helped determine the extent of the variation between the observed and predicted probabilities (Fagerland & Hosmer, 2012). The Hosmer Lemeshow test showed a non-significant value (p = .1), which indicated a negligible difference between the observed and predicted data. Such findings ensured the agreement between the data and the specified model (Meyers et al., 2013).

Most of the predictors in the model significantly influenced the level of PA among college-aged students. Meeting the PA guidelines was positively associated with students' knowledge about PA (*OR* = 1.32, $p < .001$), students' interest in information about PA (*OR* = 1.14, $p < .001$), intention to lose weight (*OR* = 1.41, $p < .001$), perceived body weight (*OR* = .79, $p < .001$), perceived level of stress (*OR* = .85, $p < .001$), sleep quality (*OR* = .92, $p < .001$), gender (male)(*OR* = 1.40, $p < .001$), race (Black) (*OR* = .78, $p < .001$), and current residence (living off-campus) (*OR* = .73, $p < .001$) (See Table 4.5).

The odds ratio coefficients represented the odds of the dependent variable for a one-unit increase in the continuous independent variable. In dummy variables, the odds ratio was the odds of the dependent variable in comparing the dummy variable with a reference group (Pampel,

2000). Thus, for the received PA information variable (*OR* = 1.3), the odds of meeting the PA guidelines was estimated to be 30% higher in students who reported receiving such information than students who did not. In terms of participant's race, the student's odds of meeting the recommended PA guidelines were 22% and 17% lower in Black and Hispanic students, respectively, compared to White students. In other words, about 78 Black students met the PA guidelines per 100 White students, holding all other variables constant.

After standardizing all continuous predictors, perceived safety had the most significant positive impact on PA (*OR* = 1.07). One standard deviation unit increase in reported safety is estimated to improve the odds of meeting PA guidelines by 7%. On the other hand, the most considerable negative impact on PA was from perceived body weight (*OR* = .85) and perceived stress (*OR* = .88) with 15% and 13% decrease, respectively, in the odds of meeting PA guidelines with one standard deviation increase.

The estimated variance component (u_j) showed the extent of associations between PA level and its indicators across the institutions. There were significant differences between universities in the impact on PA by gender (female) (u = .05, p = .01), race (Black) (u = .07, p = .04), perceived weight (u = .03, p = .03), intention to lose weight (u = .01, p = .04), living off-campus (u = .05, p = .01), and hours of volunteering (u = .01, p = .01) (See Table 4.6).

Full Random Coefficients Model

Full Random Coefficients Model was performed to determine the impact of college-level variables on the intercept and slopes of PA and student-level variables (See Table 4.7). The analysis showed the students' PA level was significantly associated with the universities' level of PA (*OR* = 1.13, p = .01); a one standard deviation increase in university-level PA raises the odds of meeting the guidelines level for a student by 13%. Additionally, the universities' safety level significantly influenced the relationship between students' PA and being a female (*OR* = .86, p =

.01), living off-campus (*OR* = .92, *p* = .02), and perceived weight (*OR* = .80, *p* < .001). The universities' level of PA significantly influenced the relationship between students' PA and a student's age (*OR* = .91, *p* = .03). The estimated variance component (u_j) was obtained to estimate the extent of associations between PA level and its indicators across the institutions. Between universities, there were significant differences in the impact on PA by gender (female) (*u* = .02, SD = .16, *p* = .02), race (Black) (*u* = .07, SD = .27, *p* = .04), perceived weight (*u* = .11, SD = .27 *p* = .03), intention to lose weight (*u* = .02, SD = .15, *p* = .02), living off-campus (*u* = .04, SD = .2, *p* < .001).

Despite the significant findings of the full random coefficients model, no improvement relative to the previous model was detected. The deviance statistic showed a non-significant reduction to provide a better fit for the data (*p* > .05). However, the variation in the mean PA in the sample of universities was considerably reduced from 1.18 to .08 (i.e., 63% reduction in variability).

Discussion

The present study sought to investigate the dynamic between levels of influence on PA and identify the primary indicators of PA among college-aged students. Using a national sample from ACHA data, a multilevel approach was adopted to quantify potential associations. To account for the clustered nature of the data, two levels were defined: student-level and college-level. HLM was employed to perform the analysis since the structure of the data demanded a multilevel method. Three statistical models were specified to address the study's research questions. The null model, the most parsimonious model with only one predictor, served as a baseline to which alternative models can be compared. In the second model, only student-level variables were included and the variables' intercept, and slopes were allowed to be random. The

third model contained both student-level and college-level variables providing a broader view of the relationship between PA and its determinants.

The sample's gender characteristics confirmed the significant gender gap in the response rate. Approximately one-third of the participants were males; such a low response rate demands attention. The widening gender gap in the response rate to questionnaires was noticed in the literature. For instance, in a large study to examine college students' response rate, Porter et al. (2004) found a constant decline in males' participation and a rise in females' response rate. Such results were supported by others (Korkeila et al., 2001; Sax et al., 2003; Underwood et al., 2000). One potential reason for the decline is the rise of females' enrollment rate with current estimates reporting that 56% of undergraduate students are females (NCES, 2014). However, such a minor difference in gender enrollment is insufficient to explain the current substantial gender gap (Smith, 2008). Some researchers suggested other survey-related factors such as the response burden of an instrument, wording of questions, methods of data collection, and relevance of the survey topic (Dillman, 2000; Dillman & Frey, 1974; Goyder, 1987; Hox & Deleeuw, 1994; Lund & Gram, 1998; Miller, 1991).

Twenty-nine percent of the sample reported engaging in the recommended four days or more of moderate PA, while 24% indicated exercising zero days. Rates of students indicating zero days were even lower in meeting vigorous PA (43%) and strength training guidelines (56%). From the sample, more than half (55%) failed to meet the minimum recommendations to obtain the optimum health benefits of PA. Previous studies reported lower rates of students who failed to meet the PA guidelines. Keating et al. (2005) conducted a meta-analysis to examine the prevalence of PA among college students and found the average rate of failure to meet PA guidelines to be 40% compared to 36% among the general population. Other systematic-review

studies estimated the range of PA levels to be between 40% and 50% (Leslie et al., 2000; Pinto & Marcus, 1995). However, the rate discrepancy between the current study and previous research can be attributed to the study's targeted population. In the present study, only college-aged students aged 18 to 24 years were included; previous systematic-reviews investigated a broader population including graduate students.

The random intercept model examined how much PA level varied between the sample of universities. The disparity in PA levels was considerably large, ranging from 13% in some institutions to 57% in others. Such a gap highlights the differences in universities' social and environmental factors. To our knowledge, there was no research focusing on the differences in students' PA across U.S. universities. Most of the current research consists of small sample studies that focus on a specific group of students or type of interventions (Sallis & Owen, 2002). Thus, addressing such a gap in the literature should be an objective for future research.

The random coefficients regression model expanded upon the null model by adding student-level and college-level variables and allowing their slopes to be random. Students' current knowledge of PA, willingness to learn more about PA, intention to manage body weight, perceived stress, quality of sleep, gender, and race significantly influenced PA. Intention to lose weight was the most influential factor with a 41% increase in the odds of meeting PA guidelines in students who intended to lose weight. In previous literature, weight control was consistently a universal predictor of PA (Luszczynska et al., 2007; Fan & Jin, 2013). Despite the considerable positive impact, researchers argued that when PA is primarily influenced by a desire to control weight, PA engagement can be unsustainable and might fail to attain its expected long-term benefits. Thus, encouraging students to rethink and embrace the broad and far-reaching

advantages of PA can contribute to an internal motivational drive that can help perform and maintain PA (Das & Horton, 2012).

The random coefficients regression models delineated the complex relationship between gender and PA. The identified gender of the participants significantly predicted PA; a male participant was 40% more likely to meet the PA guidelines than a female counterpart, holding other variables constant. Such findings affirm the persistent gender gap in PA (Guthold et al., 2018; WHO, 2016). Looking deeper to understand the fundamental reasons behind the gender gap in PA, researchers found that gender inequity originated before college entry, and subsequently, the trend was reinforced in college (Sax & Harper, 2007). For instance, youth males were twice as likely to be physically active than youth females (Barnett & Rivers, 2004). Thus, a key method to address the gender gap in PA is to examine the contributing factors during primary and secondary education as well as the nurturing environment and its role in reinforcing gender stereotypes at home and school (Genova, 1988).

In the full random coefficients model, students' knowledge of PA was associated with PA; participants who reported receiving information about PA from their respective institutions exhibited a 32% increase in their chances to meet the PA guidelines compared to those who were not exposed to such information. The role of knowledge in regulating behavior has been widely and historically accepted. In his investigation on the relationship between knowledge and self-efficacy, Bandura (1982) argued that a person's capabilities, defined by knowledge and skills, can ultimately enhance self-efficacy to perform a behavior. However, in PA within college settings, the impact of awareness and knowledge has shown inconsistent findings. For instance, Lowry et al. (2000) reported that received information had a minor impact on PA among college students. Furthermore, in the present study, the extent of the relationship between received

information about PA and engagement in PA showed a significant variability between colleges. The differences in the impact magnitude can be attributed to the unexplained variability of unmodeled indicators and the characteristics of the universities. Thus, additional research is warranted to identify emerging factors and unique differences between colleges' settings.

The situation and the environment in which students reside determined in part their level of PA. After allowing the intercepts to be random, the rate of PA among female students was significantly influenced by the college-level safety variable; universities were exhibiting a safer environment had a higher prevalence of PA among their female students. In regards to their housing, participants living off-campus were 10% more likely to meet the PA recommendations relative to students residing on-campus. The relationship was significantly influenced by the university's safety level. Thus, student living off-campus in a neighborhood perceived as not were less physically active than living off-campus in a safe environment.. Previous studies have cited students residence as a primary determinant of PA in college (Huang et al., 2003). For instance, Kapinos and Yakusheva (2011) investigated the influence of dormitory living on PA; they found students who were living in dorms to be less active than students living off-campus. However, other researcher cautioned that the negative relationship between on-campus living and PA was moderated by the residence proximity to a proper campus gym and walkability of the physical environment (Greaney et al., 2009).

Overall, the findings of the current study highlight the complexity of the relationships between PA and its determinants. PA levels among college-aged students were not directly affected by a single predictor; associations were mediated and moderator by other variables, on a similar or higher level of influence. Thus, future research directions should focus on integrating perspectives from different models and theories to uncover underlying links that account for the

unexplained variations. Designing a model that incorporates relationships between the individual and the environment (i.e., ecological model) offers an extensive method for interpreting changes in PA. Recently, there has been a paradigm shift toward an ecological approach as a promising, broad method to provide a more comprehensive perspective (Bauman et al., 2012). The results of the present study call for such a transition. Understanding the dynamic of PA determinates across their levels of influence can inform PA promotional programs to implement a well-designed and tailored PA interventions among college-aged students.

Limitations

Despite the significance of the findings, there were some limitations. Some of the variables were defined as inappropriately. For instance, safety as a broad term includes fear of crime, road traffic accidents, air pollution, and other environment-related concerns. However, in the NCHA II survey, the meaning of the term safety was left up for the participant to interpret. Additionally, some of the independent variables were operationally measured using one item with a dichotomous response. While such measurement tool tends to be efficient and reduces participants' fatigue from long surveys (Porter et al., 2004), it could psychometrically diminish the variable validity and reliability (Carmines and Zeller, 1979). Thus, future research should enhance questionnaires' accuracy and validity by designing composites with greater psychometric properties.

The data obtained relied on a self-reported questionnaire, which posed a higher risk of diminished validity in measuring the exact score of studied variables (Marsh et al.,1994). However, PA self-reported items are valid and reliable. In one study, the convergent validity of the three-dimension PA construct was cross-validated with maximal oxygen uptake (VO2 max), accelerometers, observations, and pedometers. The findings showed satisfactory psychometric

values (Tudor-Locke et al., 2002). Despite the encouraging results of PA instruments' validity, future studies should attempt to directly measure PA intensity, duration, frequency, and type of behavior. Direct tools to measure PA include advanced sensor devices, pedometers, and heart rate monitors (Ainsworth et al., 2015).

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Table 4.1

Variables Used to Predict PA Level among College Students

Variable	Question on NCHA II	Response Options
Table 1 Continued		
General health	How would you describe your general health?	Excellent; Very good; Good; Fair; Poor; Don't know
Age	How old are you?	00 – 99
Gender	What is your gender?	Male; Female; Transgender
Race	How do you usually describe yourself? (mark all that apply)	White; Black or African American; Hispanic or Latino/a; Asian or Pacific Islander; Am Indian, Alaskan Native, or Native Hawaiian; Biracial or Multiracial; Other
Received PA information	Have you received information on Physical Activity from your college or university?	Yes; No
Interest in PA information	Are you interested in receiving information on Physical Activity from your college or university?	Yes; No
Safety	Do you feel safe on this campus (daytime)? Do you feel safe on this campus (nighttime)? Do you feel safe in the community surrounding this school (daytime)? Do you feel safe in the community surrounding this school (nighttime)?	Not safe at all; Somewhat unsafe; Somewhat safe; Very safe
Estimated average Body Mass Index (BMI)	This figure incorporates reported height, and weight to form a general indicator of physical health	<18.5 Underweight; 18.5-24.9 Healthy Weight; 25-29.9 Overweight; 30-34.9 Obesity; ≥35

Table 4.1 Continued

Variable	Question on NCHA II	Response Options
Perceived weight	How would you describe your weight?	Very underweight; Slightly underweight; About the right weight; Slightly overweight; Very overweight
Weight management intention	Are you trying to do any of the following about your weight?	I am not trying to do anything; Stay the same weight; Lose weight; Gain weight
Stress	Within the last 12 months, how would you rate the overall level of stress you have experienced	No stress; Less than average stress; Average stress; More than average stress; Tremendous stress
Sleep quality	In the past 7 days, how often have you awaken too early in the morning and couldn't get back to sleep?; how often have you felt tired, dragged out, or sleepy during the day?; how often have you gone to bed because you could not stay awake any longer?; how often have you had an extremely hard time falling asleep?	0 days - 7 days
Current residence	Where do you currently live?	Campus residence hall; Fraternity or sorority house; Other college/university housing; Parent/guardian's house; other off-campus housing; Other
Hours working	How many hours a week do you work for pay?	0 hours; 1 - 9 hours; 10 - 19 hours; 20 - 29 hours; 30 - 39 hours; 40 hours; more than 40 hours

Table 4.2

College-level Variables Description

Variable	Description
PA	Percentage of student who met PA guidelines
Safety	Proportion of students who reported feeling safe
PA provided information	Proportion of students who received PA information

Table 4.3

Students Demographic Characteristics

Variable	Percentage (%)
Gender	
Male	29.7
Female	70.3
Age	
18-19	44.7
20-21	37.3
22-23	13.9
24	4.1
Year in school	
1st year undergraduate	29.2
2nd year undergraduate	20.8
3rd year undergraduate	20.5
4th year undergraduate	18.4
5th and more	4.7
Race/ethnicity	
White	70.5
Black or African American	6.8
Hispanic or Latino	11.5
Asian or Pacific Islander	11.7
Other	8.2

Table 4.3 Continued

Variable	Percentage (%)
Relationship status	
Not in a relationship	56.7
In relationship, not living together	36.3
In relationship, living together	6.9
Marital status	
Single	96.2
Married	2.4
Other	1.6
General health	
Excellent	11.8

Table 3 Continued

Very good	38.2
Good	34.4
Fair	13.4
Poor	2.1
BMI classification	
Underweight	5.1
Desired weight	60.3
Overweight	22.1
Obese	12.4
Meeting PA guidelines	
Met the guidelines	44.9
Fail to meet the guidelines	55.1

Table 4.4

Institutions Demographic Characteristics

Campus Characteristics	Percentage (%)
Type of institution	
Table 4 Continued	
Public	56.6
Private	43.3
Location of campus	
Northeast (CT, ME, MA, NH, NJ, NY, PA, RI, VT)	27
Midwest (IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, WI)	28.1
South (AL, AR, DE, DC, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, WV)	32.1
West (AK, AZ, CA, CO, HI, ID, MY, NV, NM, OR, UT, WA, WY)	12.8
Campus Size	
< 2,500 students	8.8
2,500 – 5,000 students	13.4
5,000 – 9,999 students	31.3
10,000 – 19,999 students	14.1
20,000 students or more	32.4
Campus Setting	
Very large city (population over 500,000)	18.9
Large city (population 250,000-499,999)	17.3
Small city (population 50,000-249,999)	27
Large town (population 10,000 – 49,999)	24.4
Small town (population 2,500-9,999)	10.6
Rural community (population under 2,500)	1.8

Table 4.5

Logistic Coefficient and Odds Ratios between PA and Student-Level Variables

Variable	Logistic Coefficient	p	Odds ratio	Confidence interval	
				Lower	Upper
Age	-.04	<.001	.96	.94	.98
Gender	.27	<.001	1.31	1.23	1.39
Race/ethnicity					
Black or African American	-.24	<.001	.78	.70	.88
Hispanic or Latino	-.19	<.001	.83	.76	.91
Asian or Pacific Islander	-.36	<.001	1.04	.97	1.12
Other	.04	.53	1.04	.92	1.19
Received Information about PA	.28	<.001	1.32	1.24	1.39
Interest in Information about PA	.10	.002	1.10	1.04	1.17
Perceived body weight	-.23	<.001	.79	.74	.84
Intention to lose weight	.35	<.001	1.42	1.33	1.51
Body Mass Index (BMI)	-.01	<.001	.99	.98	.99
Level of stress	-.16	<.001	.86	.82	.89
Sleep quality	-.08	<.001	.92	.89	.95
Current residence					
Parent/Guardian's home	-.31	<.001	.73	.67	.80
off -campus housing	.04	.26	1.09	.97	1.12
Working hours	-.05	<.001	.95	.93	.97
Volunteer hours	.17	<.001	1.19	1.13	1.24
Environment safety	.03	<.001	1.03	1.01	1.04

Table 4.6

Variance Components of Student-Level Variables

Random Effect	Variance component	Standard Deviation	$\chi 2$	*p*-value
Intercept	.27	.07	44.53	..41
Age	.01	.03	59.45	.08
Gender	.05	.02	27.42	.01*
Race/ethnicity				
Black or African American	.07	.01	21.56	.04*
Hispanic or Latino	.01	.11	12.59	.42
Asian or Pacific Islander	.01	.09	11.71	.50
Other	.03	.19	17.23	.19
Received Information about PA	.005	.07	53.91	.23
Interest in Information about PA	.01	.10	57.12	.15
Perceived body weight	.03	.01	64.97	.03*
Intention to lose weight	.01	.09	63.40	.04*
Body Mass Index (BMI)	.007	.01	15.21	.94
Level of stress	.009	.03	5945	.08
Sleep quality	.01	.02	45.54	.51
Current residence				
Parent/Guardian's home	.02	.14	12.75	.48
off -campus housing	.05	.24	30.38	.01*
Working hours	.01	.04	57.00	.12
Volunteer hours	.01	.11	68.14	.01*
Environment safety	.001	.02	33.44	.53

* Chi-square test is significant at the 0.05 level (2-tailed)

Table 4.7

Logistic Coefficient and Odds Ratios of the Full Random Coefficients Model

Variable	Logistic Coefficient	*p*	Odds ratio	Confidence interval	
				Lower	Upper
For Intercept 1, β_0					
Intercept 2, γ_{00}	-4.85	.013	.01	.00	.34
PA level, γ_{01}	.13	.01	1.13	1.06	1.22
Received information, γ_{02}	0.005	.80	1.00	.96	1.05
Safety, γ_{03}	.04	.85	1.04	.64	1.69
For Received information, β_1					
Intercept 2, γ_{10}	.3	.22	1.35	.83	2.18
PA level, γ_{01}	.002	.72	1.00	.99	1.01
Received information, γ_{02}	.002	.59	.99	.99	1.01
Safety, γ_{03}	.005	.86	.99	.93	1.05
For Interest in information, β_2					
Intercept 2, γ_{20}	.18	.43	1.35	.83	2.18
PA level, γ_{21}	.002	.72	1.00	.99	1.01
Received information, γ_{22}	.002	.59	.99	.99	1.01
Safety, γ_{23}	.005	.86	.99	.93	1.05
For Perceived safety, β_3					
Intercept 2, γ_{30}	.03	.51	1.03	.92	1.15
PA level, γ_{31}	-.0001	.89	.99	.98	1.00
Received information, γ_{32}	.0007	.90	1.00	.99	1.01
Safety, γ_{33}	.0006	.91	1.00	.93	1.02
For perceived weight, β_4					
Intercept 2, γ_{40}	-.59	.03	.55	.32	.94
PA level, γ_{41}	.01	.04	1.01	1.01	1.02
Received information, γ_{42}	.00	.28	1.00	.99	1.01
Safety, γ_{43}	-.10	.01	.80	.78	.97
For Control weight, β_5					
Intercept 2, γ_{50}	.83	.02	2.29	1.17	4.44
PA level, γ_{51}	-.01	.22	.99	.97	1.01
Received information, γ_{52}	.00	.62	1.00	.99	1.00
Safety, γ_{53}	.03	.47	1.03	.94	1.13
For Stress level, β_6					
Intercept 2, γ_{60}	-.12	.45	.89	.65	1.20
PA level, γ_{61}	.00	.61	1.00	.99	1.01
Received information, γ_{62}	.00	.78	1.00	.99	1.00
Safety, γ_{63}	.01	.69	1.01	.97	1.04
For Sleep quality, β_7					
Intercept 2, γ_{70}	-05	.68	.95	.74	1.21
PA level, γ_{71}	.00	.27	1.00	.99	1.00
Received information, γ_{72}	.00	.28	1.00	.99	1.01
Safety, γ_{73}	.00	.83	1.00	.96	1.02

Table 4.7 Continued

Variable	Logistic Coefficient	*p*	Odds ratio	Confidence interval	
For Age, β_8					
Intercept 2, γ_{80}	.15	.07	1.17	.99	1.37
PA level, γ_{81}	.00	.00	.91	.88	1.00
Received information, γ_{82}	.00	.80	1.00	.99	1.01
Safety, γ_{83}	.01	.26	1.01	.99	1.03
For Gender (Female), β_9					
Intercept 2, γ_{90}	.45	.24	1.57	.73	3.36
PA level, γ_{91}	-.01	.50	.99	.98	1.01
Received information, γ_{92}	.00	.85	1.00	.99	1.01
Safety, γ_{93}	-.13	.01	.86	.78	.96
For Weight, β_{10}					
Intercept 2, γ_{100}	.00	.49	1.00	.94	1.01
PA level, γ_{101}	.01	.82	1.00	.99	1.22
Received information, γ_{102}	.00	.25	1.00	.96	1.05
Safety, γ_{103}	.03	.21	1.00	.98	1.03
For Race (Black), β_{11}					
Intercept 2, γ_{110}	.70	.22	2.01	.64	6.15
PA level, γ_{111}	-.02	.07	.98	.95	1.00
Received information, γ_{112}	.00	.80	1.00	.98	1.01
Safety, γ_{113}	-.01	.86	.99	.83	1.16
For Race (Hispanic), β_{12}					
Intercept 2, γ_{120}	-.13	.77	.88	.37	2.07
PA level, γ_{121}	-.01	.29	.99	.97	1.06
Received information, γ_{122}	.00	.39	1.00	.99	1.01
Safety, γ_{123}	.00	.97	1.00	.89	1.10
For Race (Asian or Pacific Islander), β_{13}					
Intercept 2, γ_{130}	-.71	.13	.49	.19	1.22
PA level, γ_{131}	.00	.59	1.00	.98	1.02
Received information, γ_{132}	.00	.63	1.00	.99	1.01
Safety, γ_{133}	-.06	.23	.94	.84	1.04
For Race (Other), β_{14}					
Intercept 2, γ_{140}	-.42	.53	0.66	.17	2.45
PA level, γ_{141}	.00	.75	1.00	.98	1.02
Received information, γ_{142}	.01	.43	1.01	.99	1.01
Safety, γ_{143}	.06	.43	1.06	.91	1.22
For Housing (In-Campus), β_{15}					
Intercept 2, γ_{150}	-.20	.55	.81	.41	1.59
PA level, γ_{151}	-.01	.50	.99	.98	1.01
Received information, γ_{152}	.00	.34	1.00	.99	1.01
Safety, γ_{153}	.05	.24	1.05	.96	1.15

Table 4.7 Continued

Variable	Logistic Coefficient	*p*	Odds ratio	Confidence interval	
For Housing (off-Campus), β_{16}					
Intercept 2, γ_{160}	-.75	.09	.47	.20	1.11
PA level, γ_{161}	.02	.02	1.02	1.00	1.03
Received information, γ_{162}	.00	.94	1.00	.99	1.00
Safety, γ_{163}	.03	.02	.92	.83	.99
For Working, β_{17}					
Intercept 2, γ_{170}	.13	.16	1.14	.94	1.36
PA level, γ_{171}	.00	.71	1.00	.99	1.00
Received information, γ_{172}	.00	.03	1.00	.96	1.03
Safety, γ_{173}	-.01	.48	.99	.96	1.01
For Volunteering, β_{18}					
Intercept 2, γ_{180}	.31	.19	1.37	.85	2.18
PA level, γ_{181}	.00	.30	1.00	.98	1.00
Received information, γ_{181}	.00	.70	1.00	.99	1.00
Safety, γ_{181}	.03	.40	1.03	.96	1.09

CHAPTER V

SUMMARY AND CONCLUSIONS

The overall goal of this dissertation was to examine the current level of PA and what factors determine PA among college-aged students. To accomplish this goal, the PA literature was reviewed to identify related, theory-driven studies and assess the efficacy of such studies in promoting PA among college-aged students. Additionally, using national data of college students, two studies were conducted to examine the impact of student-level and college-level variables on meeting the recommended PA guidelines. The results of the three studies indicated a general theme: PA is a multifaceted and complex behavior influenced by a multitude of factors. Such variables exert their influence on PA form different level of influence.

The first study, the systematic review, examined the utility and effectiveness of theories and models adopted to promote and understand PA among college-aged students. Twenty articles met the review's eligibility criteria. Among these articles, the theories were limited to SCT, TPB, SDT, TTM, and the ecological model. SCT and TPB were the most applied theories. However, the review indicated that the findings were inconsistent. Several reasons can explain such inconsistency. Studies varied in their inclusion of common confounders and moderators, levels of influence, participants' characteristics, sample size, and measurement tools. Despite across studies differences, the review confirmed a growing trend among PA researchers towards border multilevel theories and models that combined individual, social, and environmental variables. Studies and interventions that adopted a broad multilevel approach resulted in significant findings and higher explanatory power. Despite the review's valuable results, there are some limitations such as publication bias, human error and subjective decisions, and the eligibility criteria restrictions.

The second study examined the determinants of PA level among college-aged students using secondary data provided by the ACHA, which assessed students perceived attitudes, lifestyle, and patterns of several college-related health behaviors. The findings indicated a wide gap in gender's response rate with female students significantly inclined to participate in surveys than male students. Additionally, 55% of the sample failed to meet the minimum recommendations to obtain the excellent health benefits of PA. Among demographic indicators, age, gender, and race of the students were powerful determinants of PA level. Among SCT, the perceived environment exerted a substantial impact on PA. A student's perception of safety in their residence significantly influenced their engagement in PA and meeting the recommended guidelines. The study had some limitations such as lack of accurate measurements for the dependent and independent variables.

The third study investigated the dynamic between PA influence levels and attempted to identify the primary indicators of PA among college-aged students using a national sample from ACHA data. To account for the clustered nature of the data, a multilevel approach was adopted to quantify potential associations. The disparity in PA levels was considered significant, ranging from 13% in some institutions to 57% in others. PA was significantly influenced by students' current knowledge of PA, willingness to learn more about PA, intention to manage body weight, perceived stress, quality of sleep, gender, and race. PA levels among college-aged students were not directly affected by a single predictor; associations were mediated and moderator by other variables, on a similar or higher level of influence.

The findings of the three articles offer several critical lessons. Among the most prominent findings is the crucial role of the built environment characteristics that offer cues and

opportunities for engaging in PA. Thus, to enhance the level of PA among college students, universities must strive to gauge students' perception of relevant environmental variables. Universities can then evaluate students' responses and perceptions, determine the predominant environmental barriers to engage in PA, and implement policies and programs that enable PA. These interventions can include improving students' perceived level of neighborhood safety, increasing land use mixture (e.g., stores within walking distance from residential areas), and providing walkable and bike-friendly paths.

In this dissertation, the PA level was significantly different between female and male students. This gender disparity is a result of a gender-specific pattern in PA, which deserves further investigation. Most current college programs to promote PA are designed for the general population of college students, and few consider adopting gender-specific interventions (Sallis et al., 2000). However, as the findings of this study indicated, female students are substantially influenced by certain factors that exert an insignificant impact on male students. For instance, compared to females students, male college students are motivated to participate in PA for different reasons; they seek PA for mostly intrinsic factors whereas females are motivated by external factors (Egli et al., 2011). Thus, PA researchers and university's health programs should consider such distinction to develop an effective program and achieve better results.

Limitations

As in most research studies, this dissertation has some potential limitations that must be acknowledged. First, in the review study, despite the structured and standardized methods of searching and locating relevant articles, the search did not include all relevant studies due to the review's criteria and the limited number of search engines. Second, the second and third studies relied on a sample randomized by classes and not by students. Despite randomizing classes

within each participating school, the students within each class were not randomized. Sampling methods that lack randomization in each cluster or grouping can invite selection bias (Pannucci & Wilkins, 2010). Third, the ACHA survey instruments have some methodological and measurement shortcomings. For example, the ACHA used a limited number of items to measure health factors. These variables measured limited dimensions of the constructs. Such limitation can adversely impact the accuracy of the measured variables.

Future Directions

In the last decades, the depth of research in the area of PA has increasingly progressed. Researchers have been developing innovative and valid measures to assess the level of PA among college-aged students. However, future research should be more specific in developing such measures. Currently, researchers used more than 17 validated measures of PA (Sallis & Saelens, 2000). These measures focused broadly on measuring persons in all age groups. Thus, such measures lack the specificity that considers differences between participants. For instance, only a few studies examined the validity of instruments that gauge the response of various races or age groups of college students (Crocker et al., 1997). Knowledge in PA research can be advanced by studies that assess the performance of the new PA measure that considers population differences and emerging influencing factors.

The increasing number of college-aged students reliant on technology calls for more research on technology-based interventions. The findings of this study indicated the importance of designing tailored models that consider student-specific influencing factors. Over the last few decades, multimedia devices became the norm in people's lives. As such technology can pose a risk for encouraging a more sedentary lifestyle, it also can offer an opportunity for nudging a person to engage in PA (Lu et al., 2014). Several studies showed significant efficacy of

technology-based interventions (Bond et al., 2014; King et al., 2013; Dantzig et al., 2013). However, most studies adopted observational study designs and focused on older adults. Thus, future PA research should aim to examine the impact of technology-based interventions on college-aged students using experimental or quasi-experimental studies.

Conclusions

Despite the similarities between PA and other health behavior, PA has specific characteristics that set it apart from other health behaviors. For instance, PA must be repeated frequently during one week to reap the health benefits, requires significant commitment in each session, places the body in a discomfort level, and necessitates some environmental support. Thus, maintaining PA requires a multitude of influencing factors. To promote PA among college-aged students, a comprehensive model that cater to the need of college students and that consider the unique characteristics of PA must be developed. The results of this dissertation support tailored PA models that consider personal, social, and environmental factors. Creating such models can pose a challenge for PA researchers because measuring the direct impact on one factor is confounded by several other variables. However, the far-reaching benefits of PA to the induvial, society and the environment is worth the effort.

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